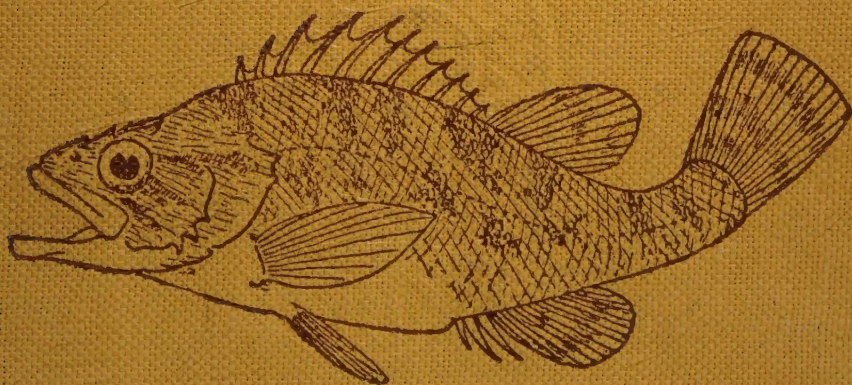


A NATURALIST'S
NOTE-BOOK
IN
CHINA



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A NATURALIST'S
NOTE-BOOK IN CHINA

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A Naturalist's Note-Book in China

by

ARTHUR DE CARLE SOWERBY

F.R.G.S., F.Z.S.

Author of FUR AND FEATHER IN NORTH CHINA; A SPORTSMAN'S MISCELLANY; SPORT AND SCIENCE ON THE SINO-MONGOLIAN FRONTIER; THE NATURALIST IN MANCHURIA; A NATURALIST'S HOLIDAY BY THE SEA; and Joint Author with Robert Sterling Clark of THROUGH SHEN KAN.

*Illustrated with numerous Photographs and
one hundred and eight Sketches by the Author*

SHANGHAI:

NORTH-CHINA DAILY NEWS & HERALD, LTD.

1925

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TO CLARICE

PREFACE

While a considerable amount of literature of a purely technical nature exists upon the fauna of China, little enough has been written in a popular way about the natural history of this vast country. This means that the young naturalists, or the casual lover of nature, is often at a complete loss to know either the names or habits of the creatures with which he comes in contact in the course of his biological investigations.

One often hears the question "What's in a name?" the implication being that names are often immaterial. To the naturalist, however, as well as to the journalist who knows his job, a name is everything. It is the peg upon which everything hangs. And since the majority of Chinese birds, beasts, reptiles, fishes and lower forms of animal life have no popular name, the only course left open to us is to use the scientific name when such exists. Furthermore these will serve as a guide to the student who wishes to push his investigations further, and to delve into the technical literature—mainly close descriptions of the numerous species—that is to be found in the libraries of museums in the home lands.

While professional biologists are busy seeking and describing new species, there are many nature lovers whose investigations are of a more general character, yet whose interest in the great subject of natural history is none the less genuine. This book has been written mainly for this class of student and reader.

As it deals mainly with the lower forms of animal life in China, it may be looked upon as complementary to the author's earlier work, "Fur and Feather in North China", which is devoted almost exclusively to the mammals and birds of the country north of the Yangtze River. It is hoped later to produce a similar book on the same groups of South China.

The chapters originally appeared as articles in the *North-China Daily News*, and *The China Journal of Science and Arts*, and the author is indebted to the proprietors of these journals for permission to reproduce them in book form.

ARTHUR DE C. SOWERBY.

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Photo by E.S. Newman
A FIVE-FOOT GIANT SALAMANDER FROM KWEICHOW, CENTRAL CHINA

CHAPTER I.

THE VOICES OF THE FOREST.

It was in a small clearing in one of the great Manchurian forests, where the silvery plumes of the tangled tussock-grass waved gently in the soft evening breeze, and the shrill trumpet-note of the marauding mosquito had already begun to replace the deeper drone of the day-time bumble bee, that I sat under the verandah of my tent and listened to the various noises that prevailed the woods at all times of the night and day.

I was tired. The long day's tramp in search of the elusive stag, that fine old monarch of the woodlands, had ended, as so many undertakings do, in disappointment, and now I stretched my weary limbs as I sat in my camp chair smoking my pipe and enjoying to the full the ecstasy of relaxation.

Before me a birch-wood fire crackled merrily as the fitful light of its flames flickered in the slowly gathering gloom; while from a large pot, slung on a sapling pole supported by two forked uprights, the pleasing aroma of mushrooms and hazel-grouse announced the approach of my evening meal. To my left, in a smaller tent than my own, I could hear my Chinese servant crooning to himself as he made ready to serve the woodland delicacies of which I should presently partake.

A great pine, a veritable giant even amongst the giants of the forest, spread its drooping branches over my tent, its millions of needle-leaves sighing gently in the breeze. Everything was peaceful, and, as I sat, my mind, half unconsciously, began to analyse the many voices of the forest.

A forest is a thing of life. Just as the human body is an aggregate of colonies of differentiated cells, which in reality are equivalent to numerous kinds of free unicellular organisms that have massed together and divided their individual functions for the common good of all, so is a forest an aggregate of living organisms, plant and animal, that go to form a whole with an entity and character all its own. In different parts of the world

and at similar altitudes and latitudes you may find forests that exactly resemble each other in every particular from the mighty trees that go toward their make up down to the smallest insect or snail that crawls in the leaf-mould below. A pine forest is a pine forest with certain definite characters, and an oak forest an oak forest: each conforms to a type. And each of these great living, complex entities throbs with life and sounds as characteristic as the trees, shrubs, flowers, and animals of which it is composed.

By day the air is ever filled with the hum of insect wings—bees, wasps, beetles, flies—all joining to form one big note of a definite pitch, just as the roar of a great town has its own note that never varies. Tinkling through this hum comes the silvery song of innumerable birds, varied occasionally by the harsh call of such species as crows, ravens, or jays. In a pine forest there is ever the soft song of the pines themselves as the wind sighs through their branches; in an oak forest, or birch wood, there is always the rustle of leaves, except when the air is perfectly still.

But things change as the sun sets and the shadows of night creep up. For a time there is a great chattering of the birds as they go to roost. This dies down and ceases, and then across the temporary stillness comes the fierce hoot of a marauding owl, or it may be only a soft *hoo hoo hoo*, for all owls have not the harsh shriek of the screech owl, or the ghostly cry of the brown owl. On the particular evening of which I write, it was a great eagle owl that first broke the lull. Booming out its far-reaching note, the great bird flapped slowly across the clearing and disappeared into the gloom beyond. Suddenly shriek upon shriek rent the air. Then silence. Some poor jay had been siezed from its perch and born away in the cruel talons of the great robber.

My meal was served, disposed of, and the remains cleared away, and once more I reclined in my chair and smoked and listened. It was quite dark now, except for the red glow of the camp-fire. And all round me were noises. The night animals had wakened and were about their affairs as busily as those of the day had been but a few short hours before, albeit they could not be seen. There was a scuffle in the underbrush close to my chair. Some mouse or wood-vole was playing with its mate. Shrill squeaks announced the fact that play had turned to quarrelling. Overhead the mosquitoes and gnats shrilled their clarion notes. A dark form came momentarily into view. It was a bat after the insects.

The squeak of a bat is even more highly pitched than that of a mouse, so highly pitched, indeed, that to many human ears it is undetectable. It is more like the sensation that one feels when squeezing a ball of silk than a noise that one hears.

Somewhere in the distant woods a fox barked, apparently stirred to curiosity by the light of my fire. And then, loud and clear, shattering the throbbing silence and ringing through the aisles of the pines, came the roar of the great wapiti stag that I had been hunting all day. There is no sound in all the world like the roar of a wapiti stag in the rutting season. Loud as the bellow of a bull, it is yet more resonant, and its glory is in the final flourish like the clear notes of a bugle. It has a ring to it that is only rivalled by the long-drawn howl of a wolf at even-song, and, like the howl of the wolf, it sets the flesh of one's spine tingling and creeping. Roar after roar the old stag threw out, taunting and challenging, knowing full well that in the dark I was powerless to lay him low. I took my rifle, nevertheless, and sneaked out into the woods. There was not the least sound of anything moving in the underbrush, yet five minutes later I heard the same taunting roar far, far away. The stag had removed himself without stirring a twig or leaf.

Back to my tent I went, and, knocking out my pipe and drawing together the logs of the fire, turned in. But before I fell asleep there came across the night air the bell-like note of some bird that I have never succeeded in identifying, and of all the voices of the forest that one is most poignant in my memory by reason of its sweetness, purity, and, above all, its mystery.

CHAPTER II.

THE HEART OF THE WILD.

Sitting one bright winter's day on the grassy side of a steep mountain in West Shansi, where the northern slopes of the great ranges are all covered with dense forests of spruce and larch, and the southern slopes are usually open and free of any heavy vegetation, my senses lulled by the surpassing beauty of the scene that lay before me, I fell to musing. Early that morning I had left camp, away down in a distant valley, with a party of fellow sportsmen bent on the pursuit of the great wild boar, whose home is in these mighty ranges. We had put up a fine old tusker, but, as not infrequently happens on such occasions, fortune favoured him and he had made his escape, breaking through the underbrush and crossing the long, boulder strewn slope with the rush of a steam engine, clearing obstacles with huge bounds, eight feet at a bound, and finally gaining the shoulder of the opposing ridge and the safety of the woods. I had picked up his trail and followed it for miles, only to lose it at last on the grassy slope on which I now sat. It was high noon, and the sun's warm rays beat down upon the mountain side, while there was a stillness in the air that took away its chill.

A great valley lay before me, and the long ridges ran into it like ribs from the mountain side. Far, far below was a winding streak of white, marking the frozen stream that lay in the deep purple shadow of the valley. Beyond rose the pine and fir clad sweeps of another range, whose peaks, towering in the air, were covered with snow. And beyond them, tier upon tier, lay yet other ranges, each a more delicate shade of mauve or blue, the furthest almost merging into the pale azure of the sky. Immediately below me was a rift in the mountain side, and in it grew various kinds of shrubs and small trees, conspicuous amongst them the red-branched and golden-barked birch. Where the sun's rays failed to penetrate, snow lay deep, a dark curving line in its whiteness marking the course of a small spring that rose at my

side. That water was sweet and pure, and I had slaked my thirst ere sitting down. It was like nectar, the drink of the gods, and ran through the veins giving new life and vigour. Never had sparkling wine tasted so good.

I thought, as I sat, of nature in all her variant moods. How wonderful is she, the mother and mistress of us all, whether we realize and acknowledge it or not! Those stupendous ranges with their masses of solid rock, the smallest of them, perched high upon some ridge, far surpassing in size man's greatest creation: the dark and silent forests, where the gentle roe moved noiselessly along the aisles between the trees: this great open slope, with its rich covering of golden grass, and occasional larch tree, twisted and gnarled by the gales that sometimes sweep these uplands: the noisy, quarrelsome jay chattering in the birch copse—each in turn has a message for him who is alive to the wonder of it all.

Far, far from the haunts of men, infinitely removed from the destruction that he works, we come upon the heart of the wild. We see it laid bare, revealing to us, as a woman reveals her heart to the one she loves, all the mystery, all the beauty, all the secrets that are hidden from those who dwell only in towns. How we come to love the wild! How her call echoes in our ears, as we toil along the dusty road of life, beckoning us from our loves, and promising us wonderful things, whispering that here we shall find no disappointment, only perfect peace and happiness! Some of us answer the call, and for a time find that peace and happiness that is not to be had amongst the dwellings of men. We realize for a while that after all the wilderness is our true home. It was man's first home, and the centuries that have elapsed since the dawn of civilization, the thousands of years that have passed since primitive man sought shelter in caves, driving out the savage monsters that already inhabited them, the countless ages of man's rise from a beast to the semblance of a god have not been sufficient to rob him of the love for the wild. In some of us this love is stronger than in others. In some it is an all-pervading motive, colouring our whole lives, rendering us strange creatures to our fellow men, since different impulses move us, but enriching us with pleasures and dreams of pleasure unknown to purer products of present day civilization.

And yet the wild cannot hold us for ever. We seek the

wilderness, bruised and bleeding from the rough usage we receive in the battle of life, and, heart to heart, we commune with the great Mother . . . We pour out our woes, we tell her of our disappointments, our shattered dreams, our broken toys, and she takes us to her bosom, whispers sweet things in our ears, wipes away the tear-stains from our faces, puts new life and hope into us. For a while we stay with her, rejoicing in the life that was our first fathers' in the dim red dawn of things. Once more we are primitive savages, free from all cares save those of the hunter. Daily we commune with the heart of the wild: daily we learn new things: wonder upon wonder is revealed to us; and then one day there comes a call that is stronger than all others, a call that rises above that of the wilderness, a call that must be answered. In the end "man goes to man." The call of the race, of home, of children, the mating call—these become dominant. We suddenly feel an overwhelming loneliness, and we take one last look at the face of Nature, the face that we love so much, and then we turn from the wilderness and back we come to the haunts of men.

Because we are what we are we cannot live without the company of our fellow beings. Each one of us needs at least one companion, *the* one companion, and strong as is our love for the wild, there is a stronger. But how fine it would be if, when the wilderness calls, *the* one woman, too, could put off this 20th Century civilization of ours, and, slipping back through the ages, take her place in the heart of the wild beside the man she loves, the new Cave Man!

Alas, how impossible is this! While man has retained much of the elemental savage, enough to enable him to face the lonely places of the earth and wrest from them the needs of life, woman has become a slave to all the comforts that human ingenuity has been able to devise. Guarded and protected, clothed in soft raiment, loving the thousand and one little comforts and refinements that she does, she cannot shed enough of the veneer of modern town life to render her fit to face the hardness of that other life which is man's special kingdom. She may come to the threshold and peep inside, but the heart of the wild she may never know. Think! Could she set out into the wilderness, the lonely, trackless forest, with its days and nights of soaking wetness, carrying all she needs, food, blankets—anything from

twenty to forty pounds in weight—upon her back, rifle in hand, and tramp and tramp and tramp, hour after hour, crossing windfalls, swamps, thickets of thorn-scrub, sleeping at night on the sodden ground, to wake up next morning cold and cramped, only to go on for another day, and then another and another? Could she leave behind every comfort, and, alone, face the sheer main ranges of the great mountain systems of this country, climbing, climbing, climbing, finding only a shallow cave at nights, sometimes without even a drop of water, losing all sense of time and the reality of things as she followed day in and day out some elusive animal of the chase, never dreaming of quitting the trail till the prize was hers? For how long could she endure the terror of the desert, the howling wastes of sand, the burning noontide heat, the bitter cold of night, the thirst, the ache of the limbs as one plods for miles and miles over the soft sinking sand? And yet it is in the desert, in the uttermost ravines and canyons of the great back ranges, in the depths of the primordial forest—in these places alone that the heart of the wild is to be found. And so man goes alone.

As I mused, a deer came out from the shelter of the birch copse, and treading daintily, with head down to graze, passed slowly along the slope below me. I raised my rifle, instinctively, but as the sights came on I lowered it again. After all I did not want to kill the beautiful animal. My mind was carried back to another such day and occasion, when I shot my first buck. What a savage I was then! My only desire was to kill. Now my greatest pleasure was to watch the graceful creature as it wandered along all unconscious of the fate hanging over it. That impulse to kill, whence came it? And why was it so strong when I was twenty, and almost gone now? Surely the answer lies in the history of our race? Take a boy. What a cruel monster he is! If he is not pulling his sister's hair, he is singeing the cat's tail or plucking the wings from a captive fly. Take the young subaltern, aged eighteen, who said "It's a fine day, let's go and kill something." And then take the man of mature years, he who still enjoys all the strength and vigour of perfect health, but who has discarded his rifle and shotgun for the camera and canvas. The boy, does he not represent the primitive savage, blood-thirsty and cruel? The young subaltern, is he not the type of the middle ages, when man's greatest pleasure was war, the joust,

daring deeds of chivalry, swashbuckling? And the mature man, the nature lover, he whose eye is still clear and bright, who is quick to see and understand, yet whose grey temples show that time has not left him untouched, surely he represents the better spirit of the age in which we live, when sanctuaries are provided for the wild things, when laws are passed for the protection of our birds and beasts?

The deer moved slowly across the slope toward a distant wood. Soon his mate followed, accompanied by an almost full grown faun. The young animal frisked about, rejoicing in the gift of life. How happy the wild things are, care free, taking no thought of ought but the pleasure of the moment! One almost wished one was a wild animal, for then the wilderness would indeed be one's home. What advantage have we over the beasts of the field, when our superior knowledge and reasoning only teach us to dread the future, to vex our souls with thoughts of death and fears of the hereafter? How many of us are happy as that young deer was happy that winter afternoon? We wander through life seeking, seeking, seeking. . . what? None of us are truly satisfied, some of us can never be satisfied. Our very minds, of which we are so proud, since it is they that raise us above the level of the beasts, make it impossible for us to be happy and satisfied, because we know that always there is something there just beyond our reach, and we want it. . . .

The shadows, all purple and blue, began to lengthen. The air became more chilly as the sun's rays slanted more, till I felt it was time to be moving. As I rose the deer saw me, and instantly, with short sharp barks, began bounding away toward the sheltering woods. The jays set up their cries of warning. I represented danger and death to these wild things, and all the world must be advised of my sinister intentions. But I did not care. After all they were my fellow beings, brothers in the heart of the wild. I did not want to kill anything. The blood-lust of the morning had completely given way to a feeling of comradeship with all of Nature's children. And so I walked along with my rifle slung over my shoulder. I had to climb the long, grassy slope, cross the ridge at the top, and descend through a great forest on the other side to the valley below, where lay our camp. I realized that I had a long tramp before me, but could not hurry. It was all too wonderful to leave so soon, and so I climbed slowly,

stopping often to look across the valleys and ridges to where the sun was now dipping in the west. Crossing the crest at last I descended into the darkness of the forest. It was cold here. The sun's rays had not struck this side of the ridge since late autumn, and everything was frozen hard. Yet there were the tracks of numerous small animals in the snow. And what a tale they told. Here had been a tragedy; there a fight between two rival males for the favour of some demure female creature, who had sat by watching the combat; there again was where a mouse had gone on a foraging expedition, only to beat a hasty retreat as the sound of danger came softly through the woods. It was a long stiff walk through that forest, but at last I came out upon the bare mountain side above our camp, and half an hour later had dropped the thousand or so feet to the valley bottom, and stood before a glowing fire of birch and pine logs.

A faint red glow tinged the sky in the west. The even star had mounted to her place, and a faint sighing sound came down from the great mountain tops as the wind rose. A long drawn wail was wafted to us from the head of the valley, telling of the sadness and hunger of some lone wolf.

"Well, what luck?" said one of my companions. "None," I replied, "but what a day!"

Yes, empty handed I had returned, and there was little enough in the larder, but what of it? Had I not communed with the great Mother, and was that not worth more than anything else that a hunter could ask? I think so.

CHAPTER III.

THE NATURAL HISTORY OF THE IMPERIAL HUNTING GROUNDS.

Something like three centuries ago, when the Manchus conquered the Ming Empire, and themselves set a dynasty upon the throne of China, a wide stretch of beautifully wooded and mountainous country lying to the north east of Peking, their new capital, was set aside as a hunting reserve and burial ground for the Imperial family. A palisade was put round this area, guards were stationed at various points along its boundaries, and no one, least of all the professional hunter and the wood-cutter, was allowed within on pain of instant death. The whole area was called the Tung Ling, or Eastern Tombs, though the more northerly parts were often spoken of as the Wei Chang, or Hunting Grounds.

The actual burial grounds, comprising several thousands of acres of lovely park-land, were situated at the extreme south, that is, nearly due east of Peking, and were enclosed within a great wall. To the north, where the mountains grow ever more rugged and precipitous, was a wilderness of pine, spruce, and oak, filled with game of all kinds, traversed by numerous sparkling trout streams, and forming a sanctuary and breeding haunt for innumerable birds and animals. Here the earlier and more sturdy of the Manchu Emperors sought recreation from the arduous affairs of state by indulging in the chase of such animals as the great spotted deer, known to the European hunter and naturalist as the Peking Stag, or Sika, the lordly tiger, and the black bear, not to mention smaller creatures such as the wild goat, the roe, and the fox.

Still further north and east, under the very battlements, as it were, of the Great Wall itself, at a place called Jehol, meaning Hot River, they built a wonderful Summer Palace, situated in very extensive and beautiful grounds.

Though Europeans were allowed to visit the Palace and grounds at Jehol, to do which special permission had to be

obtained, the Hunting Grounds were as strictly forbidden them as they were to the native hunter, with the result that very little was known to the outside world of this interesting territory till after the Chinese Revolution of 1911-12, when the Manchu power was overthrown and China became a Republic. Père David, the famous Jesuit missionary-naturalist, never visited it, though his wanderings took him over the greater part of North China and enabled him to lay the foundations of what we know of the natural history of the country to-day. A few of the larger animals of the area were known, owing to the fact that dead, or sometimes living, specimens were from time to time brought out and sold in Peking, probably by members of the forest guards. Thus the famous Chihli macaque, (*Macacus tschiliensis*, M.-Edw.), the most northerly representatives of the monkey tribe in the world to-day, the great flying squirrel (*Trogopterus ranthipes*, M.-Edw.), and the Reeves' pheasant (*Syrmaticus reevesii*) were known to science as inhabitants of the district, but the faunistic richness of the country was never even guessed.

Since the Revolution, however, the Hunting Grounds have been thrown open to the Chinese farmer and settler, the old Imperial family, who are still the owners, and being in need of funds, having found this an easy means of raising money. The settlers have been rapidly cutting away the forests, and professional hunters have come in and killed off the greater part of the game and other wild animals, and to-day the whole face of the land is turned from woodlands to smiling farmlands, and only in the more inaccessible parts of the mountains and deep ravines is anything left of the old forests and their denizens.

Before this rapid influx of settlers took place, however, I was fortunate enough to be able to pay a visit to what was, to all intents and purposes, a wild beast and bird sanctuary; for it may be explained that for the last fifty years, at least, the once important Imperial hunting expeditions into these parts had been abandoned, though the birds and beasts were still rigorously protected by the guards from molestation at the hands of professional hunters, and the trees from the woodsman's axe.

In the course of a number of years' travel in North China and neighbouring regions, while carrying out investigations upon the fauna of the country, as well as explorations of a geographical nature, I had often wished to make a collection in this little

known area, especially as I knew that so little in the way of zoological material had been brought out from it, and so, in the winter of 1914, when I first heard that the country had been thrown open, I lost no time in making up a party and visiting the district. We found the forests still intact and fairly full of wild animals and birds, though already native hunters had been busy and had killed off a lot of game. We enjoyed good sport with such birds as the Reeves' pheasant, the pucras pheasant, or koklass, as it is called in the Himalayas, the common ring-necked pheasant, and the great solitary snipe. Of big game animals we found the roedeer and the goral, or wild goat, very abundant, while everywhere the tracks of leopards and even of tigers spoke of the presence of these great felines. The few natives we met in the country spoke of the presence of bears and told us that spotted deer were also to be had, though we did not see the tracks, except on one occasion, of either of the latter. Enquiries about the monkeys elicited the fact that a few bands, consisting of from ten to forty individuals, still roamed the district, but that their whereabouts were difficult to discover as they covered a very wide area in their wanderings. Those who had seen them said that their communal habits were extraordinarily like those of human beings. They appeared to have a chieftain, some great old male ape, and posted sentries who were always on the lookout for enemies; while if one of their number were shot and only wounded the other members of the troop would try to help it escape.

But on this first visit to the Hunting Grounds the most interesting discoveries were made amongst the smaller creatures of the woods, especially in the case of small striped squirrel belonging to a genus, whose previously known range did not extend further north than mid-China. This was the little tree-chipmunk, subsequently described under the name *Tamiops vestitus*, whose habits resemble in part those of the common squirrel, in part those of the true chipmunk, while in appearance it resembles the last, but is smaller, and has softer fur. The discovery of this new form so far out of the known range of the genus to which it belongs gave the clue to the whole character of the fauna of the Hunting Grounds, for it was obviously not the same as that of the rest of North China. The Imperial Hunting Grounds represent what scientists call a faunistic island, and the presence of *Tamiops*, the macaque, the Reeves pheasant, the great flying

squirrel, and certain lizards, that will be mentioned again later, indicate that at one time a great forest belt must have stretched from Burma and Indo-China all the way to the southern boundaries of Mongolia and Manchuria, while the distinctness of the fauna of the neighbouring provinces of Shansi and the northern part of Shensi indicate that the faunistic boundary of this forest belt lay along the ridge of the great Tsing Ling range in South Shensi and along the mountains that divide Chihli from Shansi.

A few interesting birds were secured on this visit, most noteworthy of which was a specimen of a new jay, which had recently been described under the name *Garrulus diaphorus* by Mr. La Touche.*

So interesting were the results of this expedition that I decided to visit the country again during the summer months in order to ascertain the nature of its reptilian and insect fauna, to see if they bore out the conclusions already arrived at. This was done a few years later, but, owing to the extreme wetness of the season, great difficulty was experienced in getting into the country and in carrying out investigations when there. But the results obtained were well worth the trouble as they fully confirmed my previous conclusions. Amongst other interesting creatures specimens of two lizards were taken belonging to genera, neither of which had up to the time been recorded further north than the valley of the Yang-tze Kiang. These were the blue-tailed shink *Eumeces pekinensis*,† and the small-legged skink (*Leiolopisma septentrionale*, Schmidt.),‡ of which the former is a beautiful striped form with a brilliant blue tail in the young, the adult being of a dull buffy colour, and the latter is characterized by its small legs.

But the presence of such amphibians and reptiles as the Amur frog (*Rana amurensis*, Boul.), Von Schrenck's snake (*Elaphe schrenckii*, Strauch), and the pit-viper, *Agkistrodon blomhoffi brevicaudus*, Stej., suggest that the fauna of this area is also related to that of Manchuria, which a careful survey of the animals

* This has since been found to be identical with Reichenow's *Garrulus glandarius pekingensis*.

† Recently described as new by Dr. L. Stejneger in the *Occasional Papers of the Boston Society of Natural History*. Vol. 5, p. 120, 1924.

‡ Recently described as new by K. P. Schmidt in *American Museum Novitates*, No. 157 (Feb. 13, 1925).

known to occur in these two regions shows to be the case. We thus arrive at the further interesting and significant fact that the fauna of Siberia and that of Indo-China, and, through the latter, that of India and the Oriental Region generally, are connected by way of Manchuria and North-east China, the fauna of the Tartarian Region, Tibet, Mongolia, and the greater part of China north of the Tsing Ling Divide being of a totally different character and derivation.

Apart, however, from such speculations upon the distribution and origin of the animals of the Hunting Grounds, there is much of interest to the mere lover of animals and nature to be derived from a survey of the creatures discovered by myself and others in this area. For instance, it is probably not generally known that the beautiful little Mandarin teal (*Æx galericulata*), the Asiatic counterpart of the American wood-duck, has for one of its main breeding haunts the streams of these Hunting Grounds, and there the young birds grow to maturity before they come south for the winter. These wilds are also the winter home of the solitary snipe, another bird beloved of the sportsman, who, however, seldom gets a chance in China of adding one to his bag.

The streams are the home of Mollendorff's famous trout, as well as of numerous other interesting species of fish. I secured specimens of no fewer than three different forms of gudgeon, namely *Gobio ussuriensis*—whatever this may be—, *G. gobio*, the same form that inhabits British waters, and *Paraleucogobio notacanthus*, a purely eastern form. The minnow, *Phoxinus lagowskii* Dybowski, the rainbow carp (*Zacco platypus*, Schegel), and the little cyprinid, *Carassius auratus*, from which the Chinese have bred their marvellous varieties of goldfish, were also taken.

At least twenty eight species of mammal may be listed as occurring in the Hunting Grounds, of which a number have already been mentioned. Of the rest, a newly described subspecies of the common squirrel, to which I gave the name *Sciurus vulgaris chiliensis*, and whose main distinguishing feature is its almost pure black pelage with red flanks and white belly, may be mentioned as of interest, as well as a small flying squirrel of the *Sciuropterus* group, that has as yet not been identified, the raccoon dog (*Nyctereutes procyonides*, Gray), the Japanese long-eared bat (*Plecotus sacrymontis*), and a black hedgehog, which the Chinese described, but specimens of which were not secured. Other mammals were

various kinds of rats, mice, and voles, as well as the ubiquitous hare.

In the matter of birds it is impossible to give even a tentative list of the species that are to be found in this region. Numerous flycatchers and warblers make the forests their summer home, while there are many permanent residents, besides winter visitors. It would probably not be very far off the mark if it were taken that most of the species recorded from North-eastern China generally occurred in the area under discussion at some time or other during the year, and this means a list of over three hundred forms.

Insect life was very abundant in the woods and even in the new clearings, now sown with rich crops of maize and tobacco. But the mere enumeration of the species collected would serve no useful purpose here. Suffice it to say that in this branch of animal life, if in no other, the district will probably continue to be very rich, and well worth the attention of the naturalist and collector.

In conclusion it may be stated that it is a great pity, not to say a disaster, that the cutting away of the forests in this, one of the only remaining relics of the once extensive forest belt already referred to, is allowed to go on unchecked, and that soon the last home of a number of extremely interesting animals and birds will have been destroyed and the species themselves wiped out. Surely the Government could step in here and restore the old Imperial Hunting Ground to their former state as a sanctuary for wild animals and birds without doing any very great harm to anybody concerned, for the trees that are being ruthlessly cut down are for the most part allowed to lie and rot away owing to the impracticability of getting them out of the district to a market. China does not possess any wild beast sanctuary, and the area under discussion seems to be the most suitable for this purpose.

CHAPTER IV.

THE NATURALIST IN MANCHURIA.*

It does not appear to be generally known that Manchuria is not merely a land of fertile plains and hills, but also contains wide stretches of magnificent forests. Indeed, the very name Manchuria is associated in my mind with forests, though I have frequently heard people say that they did not know there were any of the latter in the country. This appears to be due to the fact that so many authors of books about the land of the Manchus have confined their travels and remarks to the province of Fengtien, or Shengking, as it was formerly called, and the narrow strip of Heilungkiang that is traversed by the easternmost section of the Trans-Siberian Railway. Even if they have travelled down the Sungari River or up the Amur they do not seem to have realized that at the back of the flat lands that form the river-beds almost the whole of the country is, or was till quite recently, covered with dense growths of pine, birch, or oak.

It is quite safe to say that, even to-day, after a great deal of timber has been cut down and exported from the country, the greater part of Kirin province and very large sections of Heilungkiang as well as of the Ussuri Valley in the Primorsk, or Maritime Province, and that wide stretch of territory known as the Priamur, or, more simply, the Amur, are heavily forested, if not with pine and spruce, at least with deciduous trees of considerable size.

Though the name Manchuria is restricted to-day to the three provinces Fengtien, Kirin, and Heilungkiang, I prefer to use it in its older and wider sense, when it included the Amur and Primorsk, which formed part of the country conquered by the founder of the Manchu dynasty, and was subsequently annexed by the Russians.

The Amur and Primorsk have been fairly well explored by naturalists working for the Imperial Academy of Science at St. Petersburg, but the rest of the Manchurian region, and more especially the forested areas, remained more or less unknown till within the last decade, when the attention of a few field naturalists,

* For a full account of the Natural History of Manchuria see the author's book "The Naturalist in Manchuria," Vol. I, II and III (published), IV and V (in the press); Tientsin Press, Ltd, Tientsin.

myself among the number, was directed toward this profitable field of investigation. During the years 1913, 1914, and 1915, I carried out a series of biological expeditions into the forested parts of Kirin and the lower Sungari Valley, which, taken with the work of others, resulted in a very complete knowledge of certain branches of the zoology of the region.

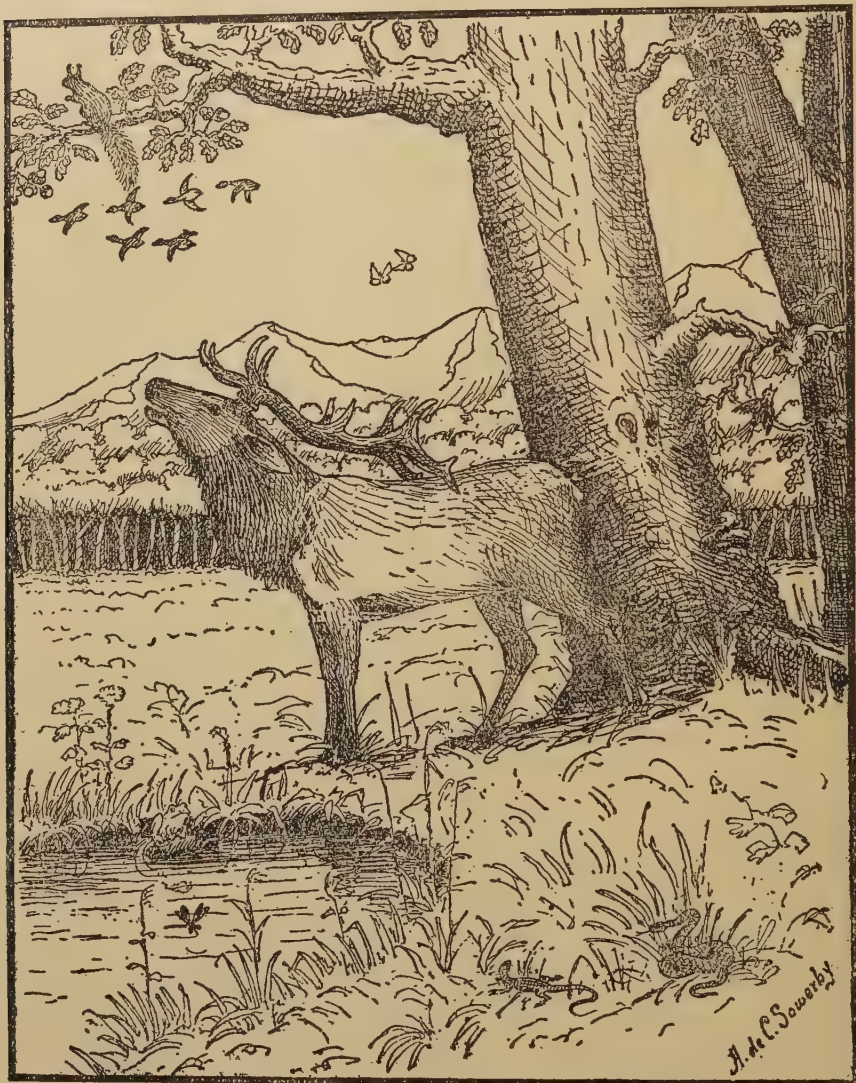
It may be said that the vertebrates, even the marine vertebrates, of the Manchurian region are very well known, as also are such classes of invertebrates as the mollusks, land, fresh-water, and marine, the insects, more especially the butterflies, moths, and beetles, and the crustaceans. In many branches of the lower forms of animal life, however, there still remains a lot of work to be done. Botanically the whole region is very well known, and a very complete work has been published in the Russian language upon the flora of Manchuria.

So rich is the natural history of this extensive area one finds considerable difficulty in speaking of it in terms of moderation. The whole country, from the borders of China Proper to the northern rim of the Amur Basin, and even beyond into Eastern Siberia itself, is full of interest to the naturalist, who never needs spend an idle or dull moment while there. Whether travelling by cart on the plains, or by boat down one of the great rivers, or on foot through the forests, there is always something worthy of note confronting him. A marvel of insect life, a lurking bird in the brush, a radiant blossom by the path, the spoor of some small animal, a fisherman's basket full of strange fish, newly caught and quivering, or a sinuous reptile creeping away in the grass—all serve their turn to enthrall the nature lover, and make the moments fly only too quickly in this paradise of living things. And if he begins but to probe and pry he is soon inundated with a wealth of material with which he will find it almost impossible to deal.

The mammals of Manchuria cannot be termed particularly varied, though there is a great abundance of individuals of certain species, chiefly amongst the murine rodents, that is, rats, mice, and voles. The larger mammals, especially the deer and the fur-bearing carnivores, have been subjected for several decades to unceasing persecution at the hands of professional hunters, Chinese, Russian, Tartar, and Korean, with the result that their once considerable numbers have been greatly reduced.

It is reported that when the railways in the north were under

construction, tigers were a positive nuisance, taking heavy toll of the coolies engaged on construction work: to-day it is extremely difficult to get a shot at one of these great felines. The handsome wapiti (*Cervus xanthopygus*, M.-Edw.) and the even more beautiful sika (*C. mandchuricus*, Sw.) are becoming increasingly rare;



ANIMAL LIFE IN A CLEARING IN THE MANCHURIAN FOREST

while the once plentiful lynx and wolverine are scarcely ever seen or heard of, except in the most remote and inaccessible parts of the forest. In some places the black bear is still plentiful, as well as the wild boar, and, in certain parts, the goral (*Urotragus raddei*, Heude). Further north in the Amur, and eastward in the Ussuri, the moose and reindeer are said to be fairly common. The once numerous muskdeer is now very rarely met with, and only is the ubiquitous roedeer common in all parts.

Of rodents, the forest contains voles, mice, rats, squirrels, chipmunks and flying squirrels; the open country hamsters, field mice, molerats (*Myospalax*), susliks, or ground squirrels; the steppe country of the north and west marmots, susliks, molerats, allactagas, or jumping rats, and gerbils. Hares and pikas, which are no longer considered to be rodents by naturalists, but are placed in a separate order of their own called *Lagomorpha*, are to be found in certain parts of the forested areas, as well as out in the open. Pikas (*Ochotona*), it may be explained, are little hare-like animals that live in colonies and make extensive burrows, much as rabbits do.

Several species of bat and shrew, as well as hedgehogs and moles may be found both in the forested areas and on the plains; while a number of small carnivores, such as the sable, marten, mink, polecat, ermine, weasel, badger, otter, fox, raccoon dog, and wild cat, together with the larger wolf, wild dog, leopard, brown and grizzly bears complete the list of Manchurian land mammals. Of these the sable is becoming almost extinct, the skins sold in the fur market as Manchurian sable being those of the marten. There are two distinct species of marten, namely the pine marten, which is said to be the same animal as that inhabiting Europe, and the yellow-throated marten (*Charronia flavigula borealis*, Radde) a much larger animal. The skin of the polecat is that sold in the market under the name of fitch.

Recently skins of the skunk have been put on the market in China in considerable numbers and are said to come from Vladivostok. As the skunk is an American animal and not indigenous either to Siberia or Manchuria, it would appear as though some one had started breeding and rearing these animals in this region for the sake of their skins.

The shooting of a fine specimen of the Manchurian gizzly (*Spelæus cavifrons*, Heude) in the Kirin forest by myself estab-

lished for the first time the fact that the grizzly is an Asiatic animal as well as North American. The Manchurian leopard (*Felis villosa*, Bonhote) is frequently wrongly called the snow leopard owing to its pale colour. It was first described from Amur Bay near Vladivostok.

Besides the foregoing mammals there are a number of marine forms, such as seals, sea-lions, sea-bears, or fur-seals, sea-otters, whales, and dolphins, that must be included in the list of Manchurian mammals.

With the exception of the small rodents, bats, and insectivores, the mammals of this country must be looked upon as of considerable economic importance and value, and the wholesale destruction that is proceeding in this direction, as well as in that of the game-birds and wild fowl, call for immediate measures in the way of government protection.

Though in my work upon the Mammalia of this country I can not lay claim to more than one new discovery—that of the wood-mouse (*Apodemus praetor*, Miller)—my investigations and collections have proved useful on the one hand in establishing the identity of several doubtful species described by earlier explorers and writers, and on the other in extending the known range of other well known forms. They have also established the fact of the uniformity of species occurring over very wide areas. Thus the handsome red-backed vole (*Craseomys regulus*, Thos.), originally described from the Tung Ling area in Chihli, China, was secured everywhere in Manchuria, from the Amur to Korea, while the chipmunk of the Yalu banks was found to be identical with those of the Kirin forests and Heilungkiang. The hare, loosely described by Radde, and called *Lepus mandchuricus*, as long ago as 1862, has been definitely established as a good species, quite distinct from the variable hare (*L. timidus*) that occurs in the Amur and on Saghalin Island on the one hand, and the various Chinese hares on the other. The range of the little mouse *Sicista concolor*, Büchner, by the discovery of the species in the Kirin forest, has been extended from the Tibetan border to Manchuria.

From the view point of the ornithologist the Manchurian region is of exceptional interest. In the first place it includes several distinct types of country, each having its own peculiar avifauna. This is more noticeable with the birds than with the mammals. These areas, taken in the order of their relative importance,

are :—(1) the forested areas, which in reality belong to the Siberian forest belt, and are characterized by such birds as the true jays, the wood owl, the nuthatch, the great black woodpecker, the hazel-grouse, the black cock, the capercaillie, and the long-tailed rosefinch ; (2) the more open country of the west, southwest, and south, which belong more to the North-east China and Korean bird zones, and are characterized by the presence of buntings, finches, shrikes, crows, rooks, magpies, various kinds of hawks and falcons, and numerous marsh birds ; and (3) the strip of steppe country that fringes an arm of the semi-desert of Eastern Mongolia, where the pintailed sand-grouse, the bearded partridge, the bustard, the wheatear, and various forms of lark make up the bird population.

Another fact which makes the ornithology of Manchuria so interesting is that the country forms the summer home and breeding resort of a host of migrant birds, whose winter haunts range down the China coasts and through the Japanese Islands and on to the Philippines. Such birds are the herons, egrets, cormorants, gulls, terns, grebes, galinules, some hawks and owls, cuckoos, kingfishers, swifts, swallows, warblers, flycatchers, and some finches. Many of these have a distinctly tropical appearance, and it is surprising to meet them so far north.

Lastly Manchuria lies right in the path of one of the main migration routes of the birds-of-passage of the Eastern Hemisphere. Ducks, geese, swans, sandpipers, snipe, plovers, cranes, terns, gulls, and other marine birds travelling northward from India, South China, the Philippines, and Australia, either pass through the Manchurian region or skirt its coasts in order to reach their breeding grounds on the tundras and Arctic coasts of Siberia. They do this apparently to avoid the arid wastes of Mongolia, finding instead an ample food supply in the rich marshes and valleys of the great rivers of Manchuria.

It will thus be realized that the ornithology of Manchuria is particularly rich in species, and the reader will not be surprised to learn that some 450 or so different forms of bird are known to occur at some time or other during the year in this country.

During a trip on the Yalu River in the spring of 1914 I was afforded an excellent opportunity of observing the migrations of birds that had obviously passed northward along the Korean coast. Such widely different forms as the egret and the grosbeak were noted, but the chief migrants at this point were the smaller pas-

serines—finches, warblers, flycatchers and the like. The woods and copses, thickets and reed-beds were alive with birds, all full of song and many a-glow with bright colours. In the autumn of the same year and of that following, while in the North Kirin forest, I witnessed the return of the migrants. This time the birds were in much larger flocks, and there was no song, while gay colours were the exception. One of the interesting features of this great southerly migration was the way one species would seem to predominate for days at a time. Thus for nearly a week while I was camped in the forest, dusky thrushes (*Turdus eunomus*), also known as *T. fuscatus*, passed by in thousands every day, to the exclusion, it almost seemed, of every other bird.

In reptiles and amphibians the Manchurian region is somewhat richer than North China or Mongolia, but poor when compared with most other countries. Poisonous snakes are represented by the subspecies of the Japanese pit-viper namely *Askistrodon blomhoffi brevicaudus*, Stej., and *A. b. intermedius*, Strauch, and the common viper (*Coluber berus*), the last occurring only in the extreme north and in Saghalin Island. Several non-poisonous snakes occur, the most characteristic and commonest species being the handsome black and yellow water-snake (*Elaphe schrenckii*, Strauch), which attains a large size, and is to be met with everywhere in the forest and along the river banks. I secured specimens measuring as much as five feet in length, while the natives told me that they reached much larger proportions. This reptile when in its new coat is extremely handsome, being of an intense shiny black, with rich markings of bright straw yellow or a duller golden yellow along the sides and under parts. The body in sunlight has an iridescent sheen. I secured one specimen without any yellow markings.

The mud turtle (*Trjonyx maackii*) is very numerous in all the large rivers. Lizards, on the other hand, are not at all common, and I secured only two specimens of the species of *Takydromus amurensis* during the whole of my time in the country. This belongs to a genus of lizards characterized by their extraordinarily long tails.

Amphibians, are extremely abundant. The beautiful little tree-frog, *Hyla arborea immaculata*, Boul., is very numerous in certain places, notably along the Yalu and Sungari Rivers, but specimens are extremely difficult to secure. Its loud, resonant note may be heard, but its whereabouts impossible to discover, owing to

the fact that the noise seems to be coming from every direction at once. • Besides this species I secured specimens of the Amur frog (*Rana amurensis*, Boul.), the common frog (*R. temporaria*), the black-spotted edible frog (*R. nigromaculata*, Hallowell), the warted frog (*R. emeljanovi*, Nikol.) the beautiful little fire-bellied toad (*Bombina orientalis*, Boul.), and the Asiatic common toad (*Bufo bufo asiaticus*, Steindachner).

A single specimen of Dybowski's salamander (*Salamandrella keyserlingii*) was secured in the forest of North Kirin where I unearthed it from beneath a rotten log. Two or three other forms of tailed amphibians are known from the country.

Dr. L. Berg, working for the Imperial Academy of Sciences of St. Petersburg, in his great work "Ichthyologia Amurensis" has ably dealt with the fishes of that great river and its tributaries the Sungari and Ussuri. I was able to add to our knowledge of the Manchurian freshwater fishes by the collections I made in the smaller streams of the Kirin forest and in the Yalu River.

By far the greater proportion of the fresh-water fishes of the Manchurian region are cyprinids, that is, they belong to the great carp family. In this particular the fish-fauna of Manchuria agrees with that of China. Indeed, with the exception of the salmonoids, which are plentiful in Manchurian waters and rare or non-existent in those of China, the fishes of the Amur, Sungari, Ussuri, Liao, and Yalu all find their counterparts in the rivers and lakes of China, though there are a certain number of species that are found in Manchuria and the Amur region alone. A fish that occurs in Manchurian waters and not in China is the pike (*Esox reichertii*, Dyb.), which very closely resembles the common European pike, whose range extends well into Siberia. A small goby that I secured in the Yalu turned out to be new, and was named after me by its describer, Mr. Ginsburg of the Smithsonian Institution. He called it *Rhinogobius sowerbyi*. This, with a species of catfish, also from the Yalu, which I have described under the name *Pseudobagrus emarginatus*, were the only new forms that I secured, though, here again I was able to extend the known ranges of several species very considerably.

A great many of the human inhabitants of the Manchurian region depend for the greater part of their food upon the fish they catch. Notably is this the case with the people that live along the Sungari, Amur, and Ussuri Rivers, where the salmon of the genus

Oncorhynchus, the same species as those inhabiting the waters of British Columbia, Oregon, Washington, and Alaska, run up stream in countless numbers every summer to spawn. From the females of these species, the famous red caviare is obtained. Another form of fish that is common in the Amur and its tributaries is the sturgeon. It is an interesting point to note in this connection, that just as in the rivers that flow into the Black Sea there are two distinct types of sturgeon, going by the generic names of *Huso* and *Acipenser*, respectively, so there are the same two types in the Amur basin, and nowhere else in the world, showing that in some way the systems of the Amur and the Black Sea were connected at some period of the earth's history. These Manchurian sturgeons are *Huso dauricus* and *Acipenser schrenckii*. It has already been pointed out how the fresh-water fish of Manchuria are closely related to those of China, but we now see that they also have some affinity with those of Europe and North America. A form of trout (*Brachimystax lenok*) closely resembling the speckled trout of British waters is very common in Manchuria, as also are a grayling and several coregonoids.

What Berg has done for the fresh-water fish of our region, Dr. P. Schmidt has done for those that inhabit the adjacent seas. The marine fish of the Manchurian region are extremely numerous and varied. It is impossible to go into the subject here, but in passing it may be noted that they are closely related to those of the waters off the Pacific coasts of North America, in many cases the same species occurring in both areas. In the Okhotsk Sea, and the deep waters that occur to the east of the Japanese Islands, some very strange fish have been secured, notably macrurids, scorpae-noids, agonoids, cottoids, blennoids, cyclopteroids, pleuronectoids, and other cold-water forms. In the Japan Sea, which washes the southern part of the Primorsk coast, many almost tropical species occur, such as are plentiful off the Japanese coasts, while to the west of the Korean Peninsula, in the Liaotung Gulf, and Korea Bay, the species are mostly Chinese in their affinities.

In insects and the lower forms of animal life, generally, Manchuria is a veritable naturalist's paradise. Butterflies, moths, bees, wasps, flies, beetles, bugs, and spiders of every hue, size and shape swarm in the woodlands and open country. On bright, warm days the air hums with the sound of their myriad wings. Gauze-winged dragonflies hover over the streams and marshes. Beetles, res-

plendent in their metallic hued and shining armour, crawl in the undergrowth, or lurk beneath stones and mouldering logs. Everywhere over the bushes and shrubs spiders spread their nets for the unwary fly. In the shade of the forest by day and everywhere by night mosquitoes by the million shrill their high-pitched trumpet call as they search for their prey; while out in the sunlight the stabbing horseflies in their hordes make life a burden for man and beast. At certain times, when the rainfall is not heavy, the black night is pierced by the myriad pin-points of light that mark the paths of the fireflies.

In spring and early summer, as dusk draws on, from the shining surfaces of the rivers and streams rise the countless fairy forms of mayflies and their kin to flit away a few short hours in play and then to die ere daylight finds them. It is then that the trout and grayling, the rainbow carp and mottled bass grow fat.

Wherever one turns, at every hour of the day or night, from April till November, one is met by some wonder of the lower animal world, and it is only when the cold north winds of coming winter bring the first heavy falls of snow that this source of never ending delight is withdrawn from the student and nature lover.

Turning from the interior to the sea-coast one finds this wealth of invertebrate life well sustained in the numerous marine forms that occur along the shores. All kinds of shells are to be found, while the more rocky parts yield an abundance of crustacean life that is hard to beat anywhere in such northerly latitudes.

A very interesting point in connection with the crustaceans of the Manchurian region is the presence in the Amur basin of two species of crayfish that belong to a group only represented in this region and Japan. The genus has been given the name *Camberoides*, because of its affinities with the North-east American genus *Camberus*, rather than with the European and North-west American genus *Astacus*. This is a very peculiar distribution of the three chief groups of crayfishes belonging to the Northern Hemisphere. It is further remarkable that no crayfish is known to occur in Siberia. The two forms found in Manchuria and the Amur are, *Camberoides dauricus* from the head-waters of the Amur and certain parts of Kirin, and *C. schrenckii* from the Lower Amur.

The land-snails and mollusks of Manchuria, as well as the insects show very close affinities with those of Europe, in many cases the same species occurring in both regions. This fact,

amongst others, goes to prove that the fauna of the land-mass of Eurasia, as the two continents have been called, is divided into two distinct sections by the great desert belt that stretches from Morocco through North Africa, Arabia, and Central Asia to the western borders of Manchuria itself, and that it was only by way of Manchuria that certain of the northern forms of animals managed to spread to regions south of this desert belt. This in turn has a bearing upon the natural history of China, and tells us why the fauna of the north shows certain rather startling relationships to that of Europe, and also why the only tailed amphibians, newts and their kin, that occur south of the desert belt are to be found in South China and the Japanese Islands. They reached these habitats by way of Siberia and Manchuria.

Of the flora of Manchuria one almost hesitates to write. The subject is so vast that it is entirely out of the question to do it even the barest justice here. However, an account of the natural history of such a region as that under discussion would not be complete without some mention of its plant life, and botanists must forgive me for the inadequacy of the following remarks.

I have already outlined the extent of the forests which form so important an asset to the country, but mention should be made of the more important of the trees that go to form them. Formerly, in the forests along the Yalu, and in areas recently opened up by settlers and exploited by lumber companies, conifers such as pine, spruce, fir, and, at the higher altitudes, larch formed the bulk of the heavy timber, but these have been cut away to a considerable extent, and only the deciduous trees such as oak, walnut, maple, and birch remain. In the swampy areas that are so prevalent in certain parts of Kirin and Heilungkiang, the white birch is the commonest tree. There still remain vast areas of these two provinces as yet untouched by the woodsman's axe, where the valuable conifers form the main covering of the low hills and mountains, and it is these reserves, apparently, that the Japanese have been after in their negotiations with the Chinese Government for the timber rights in Manchuria. It is to be hoped that in the exploitation of these fine forests they will not forget to re-plant coniferous trees as they cut out those already in existence.

Of herbaceous flowering plants Manchuria displays a wealth and variety that baffles description. Clematis, anemone, lily, orchis, iris, larkspur, monkshood, rose, canterbury-bell, ranunculus,

and other plants with handsome blooms grow in rich profusion in the open, while the woods are filled with violets, pansies, and primulas. In places the lily-of-the-valley covers acres of ground, the rich white blossoms ladening the air with their delicate perfume.

Ferns and other Cryptogams are very abundant, especially in the forests, where also a wonderful variety of fungoids, edible and otherwise, cover the fallen trees and dead-wood.

Mention must be made of numerous fruit-bearing trees and shrubs that occur throughout the country. Of these the edible haw, the wild apricot, and the wild vine deserve special notice, as they form an important part, in their seasons, of the food of the natives. Other wild fruits encountered are the crab-apple, the red currant, the raspberry, a red dewberry, the strawberry and a large, sweet berry of a green colour with many small pips, and flavour like that of a gooseberry, which grows on an enormous vine.

Wild asparagus is very common, the young shoots being sufficiently large to form a useful vegetable; while the young fronds of some of the larger ferns may also be eaten.

Numerous plants with medicinal properties occur, and one of the industries of the country is the hunting for and gathering of these. Foremost amongst them is the famous ginseng (*Panax ginseng*). The Chinese have a quaint couplet that runs:—

Kuan-tung chen san teng pao

Jen-seng tiao-pi wu-la tsao

and may be rendered:—

Three valuable things come from "East of the Pass,"

Ginseng, sable, and wula grass.

Wula grass is a peculiar fibrous grass which when dry is warm, springy, and does not easily break. The natives use it to stuff into their leather moccasins, called *wu-la*, thereby keeping the feet free from frost-bite and bruising. Without this grass it is impossible to wear *wu-la*, hence its value.

CHAPTER V.

THE BLUE SHEEP OF KANSU.

Big game hunters, the world over, are ever on the look out for new or rare animals on which to try their prowess, which fact makes it all the more remarkable that the blue sheep, or bharal, to give it its Hindustani name, though occurring in China, is not better known. Indeed, to most sportsmen its very existence in China has remained a secret, though the magnificent big horned sheep, or argali, of North-west Shansi, the peculiar animal, half goat, half ox, called the takin, of the highlands of West and Central China, and the various members of the goat family, such as serows and gorals, are all well-known.

The blue sheep, though not comparable with the argali in size, is, nevertheless, considerably larger than the domestic sheep, a full grown ram weighing something over 100 lbs., and standing some 3 feet at the shoulder. The horns differ from those of the sheep in that they rise first upwards and then turn outwards and backwards, instead of curving in a circle. They are finely striated and fairly smooth. The record length is $33\frac{1}{4}$ " , the specimen having been shot on the 1904 Lhasa Expedition : the record basal circumference is $15\frac{1}{2}$ " , being that of a sheep shot in Ladak. The record Chinese specimen up to date is 26" in length and 12" basal circumference, the specimen having been picked up in Szechwan by Mitchell. The horns of the female are considerably smaller than those of the male, but are, nevertheless, shapely and make a handsome trophy. The colour of this remarkable sheep is greyish buff on the body with a tendency to brownish in the summer pelt and more greyish in that of the winter. The belly, rump, back of the legs and bands down the side of the face are white, while black extends down the face between the white bands, the throat and chest, and front parts of the legs, a stripe dividing the brown from the white on the flank, and the tail also being black. In the female the markings are very much less distinct, and only on the front of the legs and on the tail does black occur. The tail is longer than is

usual with wild sheep, but not as long as in the goats. The hair is short, very thick and smooth, the coat being well suited to withstand the vigorous climate in which this sheep lives.

The bharal forms a connecting link between the true sheep and the goats, but pertains slightly more to the sheep. It has, however, been separate from the genus *Ovis*, to which the true sheep belong, and has been placed, by Hodgson, in a genus of its



THE BLUE SHEEP

own to which the name *Pseudois* has been given, the Himalayan species being known to science as *Pseudois nahoar*, while the Chinese form has recently been described by Lord Rothschild as a distinct subspecies *P. n. szechuanensis*.

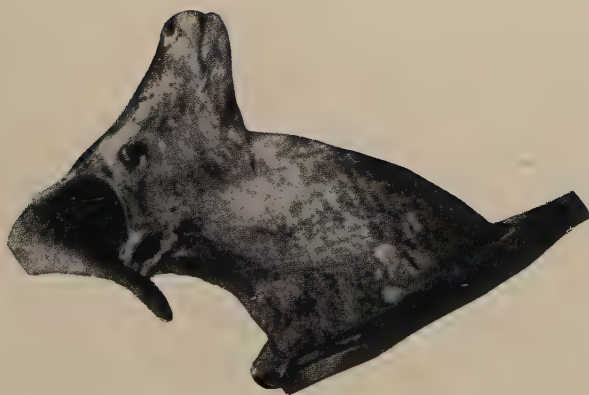
The bharal ranges from Ladak in the west to the North China in the east, and from the Himalayas in northern India in the south to the Kuenlun Mountains in the north of Thibet in the north. It is not, however, universally distributed over this wide area, but apparently occurs locally where it finds suitable country

amidst the barren and precipitous mountain peaks that it loves. Up to quite recently, the only places in China where the blue sheep was known were South-west Kansu and Western Szechwan along the Thibetan border. Recently, however, Mr. J. H. Denver-Jones, while travelling in Kansu, discovered the species in great numbers in a little known area lying to the south-west of Ning Hsia in Northern Kansu. While journeying along the road that lies between Ning Hsia and Lanchoufu, the traveller stopped at an inn in a small wayside village. On the floor he noticed the head of a blue sheep, and, on making enquiries of the natives in regard to this, he elicited the fact that the animal was very plentiful in the immediate vicinity. Accordingly, he went out with his rifle, and, to his surprise, found several herds of blue sheep grazing on the mountain sides along the valley. He had no difficulty in securing several good rams, the heads of which he ultimately brought down to Shanghai, where the skulls were prepared and mounted in the Shanghai Museum for Mr. A. J. Hughes, of the China United Assurance Society, to whom he gave them.

He also brought a live lamb of the same species, which he purchased in the vicinity, to Shanghai, and this little animal was placed for a time in the garden of Mr. Benbow Rowe, where it did very well. Subsequently it was taken over by a dealer, who wanted it for export to America. Since then it has been lost sight of. This is undoubtedly the first time that a living specimen of the bharal has been brought to Shanghai, while the discovery of a new habitat, where the sheep is both plentiful and easily accessible to the sportsman, is of considerable interest.

Still more recently specimens of the blue sheep have been shot in the mountainous area to the north of the Ordos Desert, and the accompanying plate shows the mounted head of one of these.

The writer cannot speak at first hand of the habits of the blue sheep, but, to judge from accounts of those who have hunted this animal, they are very similar to those of the general run of wild sheep. Occupying the high, desolate and precipitous mountains, the bharal associates in flocks of ten to a dozen individuals, consisting of a number of ewes with one adult and possibly two or three very young rams. They are said to be extremely difficult to approach, as is the case with most wild sheep in districts where they are hunted, but apparently in the area already mentioned in Kansu they are not sufficiently persecuted to render them shy.



MOUNTED HEAD OF BLUE SHEEP FROM NORTH-WEST SHANSI

Sportsmen who wish to gain further information upon this interesting animal, should read Frank Wallace's account of hunting blue sheep in Western Kansu in his book, "The Big Game of Central and Western China." His account of its habits agree well with those of other writers. Other accounts may be found in Lydekker's "Royal Natural History," and in his book, "Wild Oxen, Sheep and Goats," while "Roland Ward's Records of Big Game" contains a short account of the animal, its distribution, and records of the horn measurements of various fine specimens shot by big-game hunters in different parts of Asia.

There are two fine specimens of this sheep from Western Szechwan in the Museum of the Royal Asiatic Society, in Shanghai. Of these, the ram is a really splendid animal. The specimens are in winter coat, and, owing to the extreme greyness of the colour, show well that the Chinese form is at least racially different from that of the Himalayas. A further interesting point about the Chinese form is that the horns take more of an upward turn than is the case with specimens from Ladak and the Himalayas. According to Wallace, the Chinese name for the blue sheep is *Ngai Yiang*, which means "cliff sheep."

CHAPTER VI.

WHAT IS A CHINA PONY?

Ever since Europeans first came to China, and more especially since the Treaty Ports were opened and settlements of Britishers began to establish themselves up and down the coast and along the Yangtze Valley, the so-called "China Pony" has been of very general interest—to many of paramount importance—for he has supplied the means of indulging, at a comparatively low cost, in the British national sport—racing. Not only so, but he supplies to all a very good mount, and many a foreign resident in China, missionary as well as business man or merchant, is able to enjoy his daily canter or cross-country gallop, who could never afford the luxury of a horse in the home lands.

A hardy little beast, needing but little care, and with an endurance that is astounding, our friend has found for himself a very warm corner in the hearts of nearly all of us, and this finds echo in the heat of the discussion that has recently arisen over the questions in racing circles as to whether the past standard of racing ponies is to be maintained, and if so, how is it to be managed with the increasing difficulty of securing first-class animals of a pure breed; and how racing is to be kept within the means of the average member of the race clubs.

These discussions have centred, to a considerable extent, on the question as to what the China pony really is, a question which up to the present no one seems to have had the temerity to undertake to answer. In a short article which appeared in the *North-China Daily News*, I tried to point out the line that would be followed by a biologist if he had to determine whether or not the animal known to racing men as the "China Pony" was a distinct species, race, breed, or type, and since that was written I have further investigated the problem, and, with the aid of numerous photographs of past race winners on the Shanghai courses, have arrived at certain conclusions, which, however, are provisional only, and the validity of which depends on whether they are confirmed by measurements taken in the flesh of a large series of ponies. To complete the investigations along these lines would



"BEDFIELD"

A Kiangwan Subscription Griffin : 13.1 hands. Won the $1\frac{1}{2}$ mile handicap, carrying 175-lbs. The second pony stood 13.3 hands, and carried 129-lbs. It was beaten by several lengths. This is a typical "China" pony



"BEACONSFIELD"

A good type of "China Pony," slightly longer in the leg than "Bedfield", however, and less deep in the body

require more time than I have to devote to the task, but I feel confident that if some one will undertake to measure, say, a hundred race ponies, strike averages of each set of measurements, and compare them with each other, so as to get their relative proportions, and also with similar measurements of other known breeds of horses and ponies, he will be able to define very accurately what constitutes a China pony, and those interested will be in a position to amend any rules in their clubs which are affected by the question.

But apart altogether from the racing side of the question, it is of considerable interest to everybody who has anything to do with the pony in China to know whether he is or is not a distinct type, and if so, exactly what are his individual characteristics.

To begin with we are confronted with an anomaly in the very name of the animal with which we are dealing. He is called the "China Pony," which name presumably dates from the time when foreigners first came to China and bought ponies from local native dealers without knowing that they all came from Mongolia. There are real China ponies, that is to say, ponies that are born and bred in China and belong to breeds that are indigenous to the country, but these come from the west, are small, and are never used for racing, and seldom for any other purposes, except for children to ride, by Europeans in China. Thus the "China Pony" is in reality a "Mongol Pony," and while we may continue to use the old name we should never lose sight of this fact.

The real questions to be determined are whether or not the ponies that are reared throughout the length and breadth of Mongolia can be considered as conforming to one type, and, dependent upon that question, whether or not the ponies that have been raced in China up to date have all been of one type, and that the same type as the one found in Mongolia.

It is impossible to go over Mongolia and take measurements of series of ponies in various parts, and so, in our efforts to determine whether or not there is one breed or a number in that country, we must depend on the evidence of those who have travelled there or who have taken sufficient interest in the matter to find out where the animals they have seen in China came from, and whether amongst these there is sufficient variation according to locality to show if there are a number of types or only one.

As a matter of fact I can claim to have done both of these

things, and I find that others who have done the same are very much of the same opinions as myself in the matter. Personally I should consider that the ponies found in Mongolia all belong to one very distinct type, their relative proportions being very much the same, no matter from which part of Mongolia they come, though the animals themselves vary to a considerable extent in size according to the district in which they are born and reared. Thus the pony from the Ordos Desert is very small; that from the Ili district in the extreme west very large; that from the Grass Lands of Inner Mongolia is intermediate between these two, as also is that from the Urga districts.

But as far as I have been able to make out, the proportions of all these animals are about the same, that is to say, the length of the neck and legs in proportion to the length and depth of the body are about the same, whether the individual be a small pony from the Ordos or a large one from the Ili district. It may be mentioned that in North Shansi the Chinese carters use an animal that is somewhat heavier in build than the average Mongol pony, but I have been unable to ascertain where these are bred, or how the Chinese come by them. They may represent a distinct breed, or it may be that all heavily built ponies found throughout the herds in Mongolia are taken to this part of China for sale, since there is a special demand for that class there.

Incidentally it may here be given as a very general opinion amongst experts, and one with which I concur, that the Mongol pony is the direct descendant of Przewalski's wild horse, whose home is in the steppes of Western Mongolia and Central Asia. Domestication may account for the differences that occur between the Mongol pony and Przewalski's wild horse, or they may be due to the introduction of other blood. Przewalski's wild horse is the nearest modern representative of the pre-historic wild horse of Europe, and the Mongol pony is the nearest thing in domesticated horseflesh to Przewalski's animal living to-day. It is from the latter animals that our Mongol pony gets, amongst other things, its large head and short neck.

According to Lydekker, quoting Campbell, who travelled extensively in Mongolia, the best ponies in Mongolia come from the Kurulen Valley in the north-east, and this introduces us to the crux of the whole matter that has raised the question of the status of race ponies. Are these ponies that are bred in areas adjacent to Siberia



" WAKEFIELD "

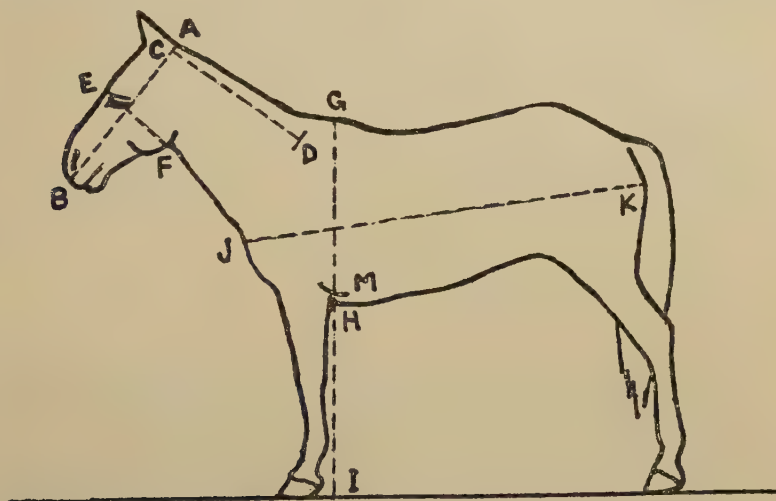
A famous long-distance pony. Exceptionally long in the neck and leg



" THOMAS A BECKET " : 13,2

Winner of twelve races while owned by Mr. A. G. Nugent

pure specimens of the stock as represented throughout Mongolia generally? And, short of getting the actual pedigree of each pony, this is a question that can only be settled by biometric methods; that is to say, by taking a set of measurements of a great many individuals from all over Mongolia, and classifying the animals accordingly. If it be found that marked variations occur only in animals that have been bred along the Siberian frontier or in closely adjacent areas, it will be necessary to assume that there is an infusion of outside blood in their veins from Siberian animals in which the varying features are prevalent. Or in other



Outline of a typical "China Pony," which shows the average proportions as suggested in this book, and the points between which it is suggested that measurements be made.

C-D. Length of Neck

A-B. Length of Head

E-F. Depth of Head

G-H. Depth of Body

G-I. Height at Shoulder

M-I. Length of Leg

J-K. Length of Body

words; if from an area close to the Siberian frontier, where the large so-called Russian horses (whatever they are), with their comparatively long legs and necks, are prevalent, we find that the animals bred by the Mongols have a tendency to be markedly longer in the legs and neck than those from elsewhere, then we must assume that they have Russian horse blood in their veins. Occasionally one meets an animal from Ili in which the proportionate length of leg is distinctly greater than in the average, and the neck is longer

and more arched. Such animals show very plainly that they have some other strain in them. They are most common in Western Kansu, and the Chinese say that they have some foreign horse in them.

The chief distinguishing characteristic of the China pony as displayed in animals that have won races in China and therefore have been photographed are :—

1. The large size of the head and its proportionate depth from the forehead between the eyes to the bottom of the jaw near the angle.
2. The shortness of the neck and the fact that it shows a slightly concave outline (ewe-necked) instead of being convex (arched) as in other breeds.
3. The great depth of the chest.
4. The shortness of the legs.
5. The great length of the body.
6. The thickness of the hocks.
7. The rather sharp slope of the rump.
8. The low set of the tail.
9. The excessively shaggy and long winter coat.
10. The hairiness of the fetlocks.
11. The heavy mane and tail, the latter having the long hair extending right up to its junction with the body.

The first five of these characters can be put to the test of measurement. As far as I have been able to ascertain the following proportions distinguish the "China Pony" :—

- (a) The length of the head goes into the length of the body about $2\frac{1}{2}$ times.
- (b) The depth of the head is more than half the length.
- (c) The length of the neck is less than the length of the head.
- (d) The depth of the chest, measured from the top of the shoulder, is a little less than half the height at the shoulder. In some cases it is exactly half.
- (e) The height at the shoulder is considerably less than the length of the body.

The proportions and the characters listed above define the "China Pony."

Now an average of each of the measurements suggested here can be derived from a large series of actual ponies, and a definite standard can be evolved. If an animal conforms to this standard



A TYPICAL ILI PONY

Note the large head, short neck, and sloping rump ; typical points of the "China Pony"



"CHINA PONIES "

As they appear in the rough, and in which state they look very much like the wild horse of Central Asia (*Equus przewalskii*)

with but comparatively little variation (the maximum of variation allowed to be fixed), then it may be considered as a pure bred "China Pony." If it does not then it must be looked upon as having some other strain in it, or else as belonging to some other breed altogether.

CHAPTER VII.

THE PANGOLIN.

One of the most peculiar animals in China, both in appearance and habits, is the pangolin, or scaly ant-eater. Belonging to the order *Edentata*, which is so named on account of its members, with but few exceptions, being toothless, and which includes the sloths, true ant-eaters, armadillos and aardvarks, or earth-pigs as well, the scaly ant-eaters are confined in their general distribution to Africa, south of the Sahara Desert and Southern and South-eastern Asia, a number of different genera and species being recognized.

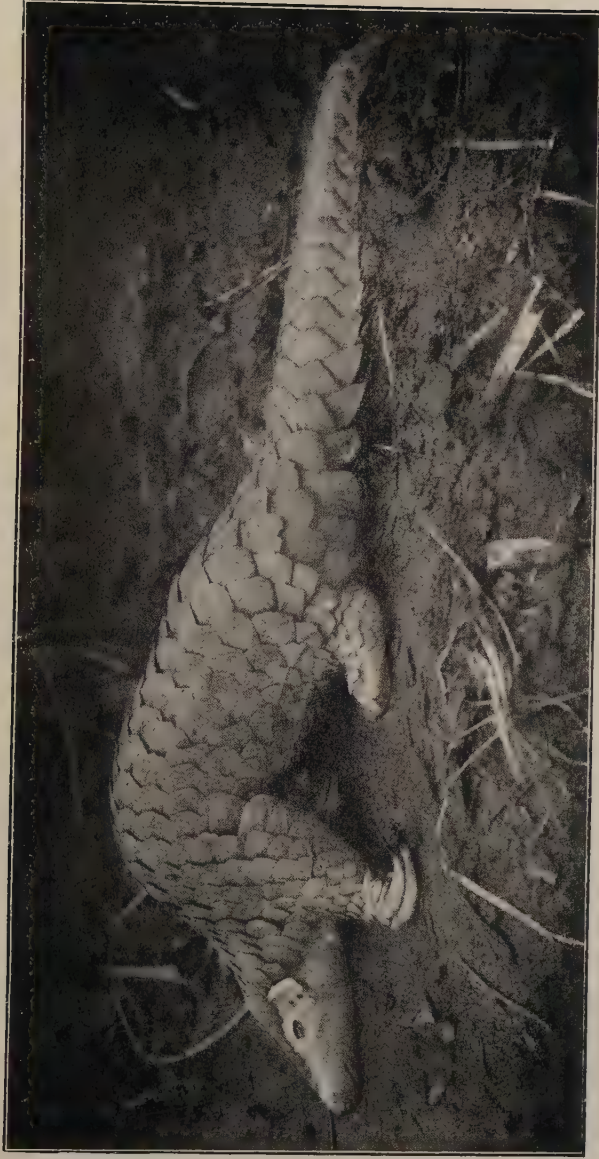
In Asia there are three distinct forms, one named *Manis pentadactyla*, L., occupying North India, Nepal, Assam and South and South-eastern China, another named *Phatages crassicauda* occupying Southern India and Ceylon, and a third named *Paramanis javanica* occupying the Malayan Peninsula and Islands*.

Of these we are concerned here only with the first, *Manis pentadactyla*, which is the form found in China, though this name was formerly, though wrongly (as shown by Pocock), applied to the pangolin of South India and Ceylon. It has also been commonly known amongst zoologists as *M. aurita* and *M. dalmanni*, both of which names are now recognized to be synonyms of *M. pentadactyla*.

As far as the present writer has been able to ascertain, the range in China of this species is from Chekiang (possibly Southern Kiangsu), through Southern Kiangsi, Southern Anhui, Fukien, Kwantung (Canton), Southern Hunan, Kwangsi, and Yunnan into Indo-China. It may also occur in Kweichow and Southern Szechuan.

Lydekker describes the pangolin as looking like "an animated spruce-fir cone furnished with a head and legs," a description

* Mr. R. I. Pocock in a recent paper in the Proc. Zoo. Soc. Lond., 1924, pp. 707-723, has revised the classification and nomenclature of the Pangolins, and the above names are based on his findings.



THE CHINESE PANGOLIN (*Manis pentadactyla*)

which is very apt. Indeed, with the whole of the upper surface of the head, the neck, the back and sides of the body, the outer surfaces of the legs, and both upper and lower surfaces of the long, thick and somewhat flattened tail covered with large, horny, overlapping scales, with a few bristle-like hairs showing between them, the short legs and creeping movements, the pangolin looks more like some prehistoric reptilian monster than a present day mammal. The sides and lower surface of the head are covered with sparse short hair, as is the under surface of the neck, the under surface of the body and the inner surfaces of the legs. The head is small, the muzzle long and slender, the small mouth being situated at its extremity. The tongue is excessively long, measuring from 8 to 10 inches, is soft, extensile and very mobile. The ear is small and rounded, the eye not very large. The fore feet are armed with long, curved and powerful claws for digging, the claws on the hind feet being shorter, but stout. There are no teeth, the lower jaws being slender and weak. In the skull, which looks very primitive, there are no separate eye sockets, while the skeleton is peculiar in that there are no collar bones. The colour of the scales is brown, the hair on the scaleless parts of the body being a pale brownish colour. Our species reaches a maximum length of four feet, of which over one-third is taken up by the tail.

The food of the pangolin consists of white ants, or termites, and the larvæ of true ants, bees and wasps. It will not eat the adults of true ants or other insects, except the soft-bodied termites. To secure its food it is armed with the powerful claws already mentioned, with which it can dig deeply into the earth after termites, or tear away the outer parts of ant-eaten trees. Its long, sticky tongue darts with lightning rapidity down the numerous galleries of the insects' homes, licking up the juicy, white grubs.

In the country inhabited by the pangolin, white ants are extremely abundant, and, while the headquarters of each colony of these insects is usually at a considerable depth below the surface of the ground, the insects frequently carry their long galleries up into old trees. There is also a species of ant that makes a huge nest, not unlike that of a wasp, high up in the branches of trees. To get at the termite galleries and ants' nests in the upper branches of trees, the pangolin is able to climb with extraordinary agility, considering its clumsiness on the ground. In climbing it uses its tail, which is to a considerable extent prehensile, holding to

branches with it. When burrowing for its food the pangolin uses its powerful fore paws, throwing up the earth in a shower and sinking rapidly into the ground.

It lives in a burrow of from eight to twelve feet in depth, with a large chamber at the end. It always blocks up the mouth with earth when it returns home after its night's wanderings. The pangolin is seldom, if ever, seen abroad in daylight.

When progressing on all fours, it turns the claws of the front feet backward, walking on the backs of the claws. The hind foot is placed squarely on the ground. The pangolin rises easily on its hind feet, which, like those of the bear and man, are plantigrade; that is to say, heel, sole and toes are all on the ground together. When alarmed or when sleeping, the pangolin curls itself up into a ball, wrapping its broad tail over its head, and tucking its limbs away. It thus presents a complete set of armour to its enemies and is well protected at every point.

The adult female carries her young on her back, till such time as they can safely venture abroad on their own account. One or two young are born at a time, in the spring. Nowhere common, the pangolin is a lonely animal living in the wilder parts of uncultivated country. Its intelligence is of a low order.

Mr. Clifford Pope, of the Third Asiatic Expedition of the American Museum of Natural History, who has recently made a good collection of mammals, as well as of reptiles, amphibians and fish in Hainan Island, tells me that pangolins are extremely common in that island.

The Chinese trap the pangolin by placing a deadfall log at the mouth of its burrow. Its flesh is said to be very good eating. They look upon the animal as being of considerable medicinal value, and medicine shops will pay up to \$8.00 for a specimen. In Fukien the animal is known as *La-li*.



THE PANGOLIN ASLEEP



DEAD PANGOLIN

Showing under side of body and long tongue hanging from mouth

CHAPTER VIII.

THE REPTILES OF CHINA.

Reptiles, as represented on the earth to-day, are divisible into four main groups, or orders. These are :—

- (1) *Crocodylia*, containing the crocodiles and alligators.
- (2) *Chelonia*, containing the tortoises, terrapins and fresh-water and marine turtles.
- (3) *Squamata*, containing the lizards and snakes.
- (4) *Rhynchocephala*, containing the beaked lizards.

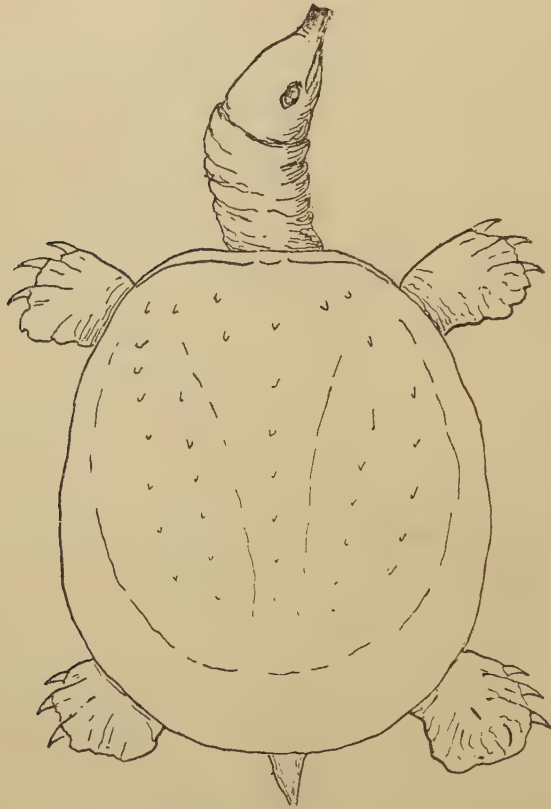
The order *Squamata* is divided into two sub-orders, that containing the lizards, to which the name *Sauria* has been given, and that containing the snakes, called *Serpentes*. Other names are sometimes used for these two sub-orders, but these were the ones chosen by the great Swedish naturalist Linnè, or Linnæus, and there is no legitimate reason why they should be changed.

The first three orders mentioned above are represented in China, but the last, *Rhynchocephala*, which contains but one living species, the tuatera (*Sphenodon punctatus*), has no representative in any part of the world except in the small islands off the north-east coast of New Zealand. This remarkable reptile, though bearing an external resemblance to our present day lizards, differs in its skeletal structure to such a degree as to warrant naturalists' separating it entirely from the latter. It is characterized by the presence in the middle of the upper surface of the head of a rudimentary eye, which is buried in the bone, and only visible through the skin in young specimens. This is called the "pineal eye," and it is believed to have functioned in the ancestors of the present day reptiles, though now it is useless.

In the next chapter we are dealing with the members of the order *Crocodylia* that occur in China, so there is no need to discuss it further here, except to remind the reader that only two of these great reptiles can be claimed as Chinese, the little Yangtze alligator (*Alligator sinensis*, Fauvel), which is confined to

the Lower Yangtze Basin, and the estuarine crocodile (*Crocodilus porosus*, Schn.) which is said to occur in the rivers of the extreme south.

The great order *Chelonia*, or *Testudinata*, as it is also called, is not as well represented in China as it is in other parts of the world, but there are some interesting species. North of the



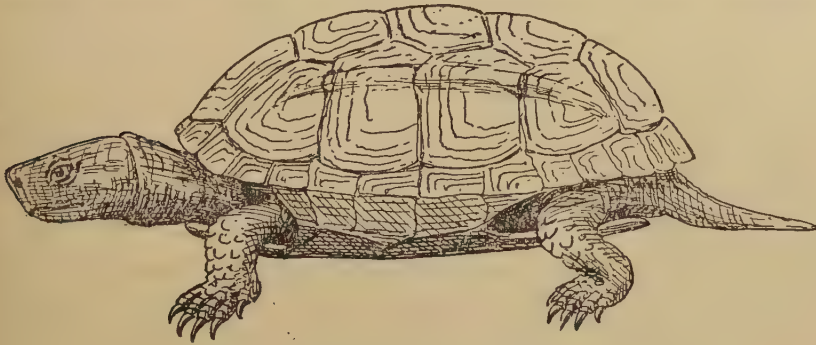
THE CHINESE MUD-TURTLE (*Trionyx sinensis*)

Yangtze Valley the only representatives are the soft-shelled, river or mud-turtles, though a terrapin has been recorded (doubtfully) from the Tientsin district.

South China boasts a good many more species, mostly terrapins, but even so there are not a very great number of them. There is considerable doubt attaching to the status of the various

species of mud-turtle which have been described from China. The common form is known as *Trionyx sinensis*, Wiegmann. The Peking mud-turtle has been separated under the name *T. schlegelii* and the Manchurian form under the name of *T. maackii*, both by Brandt, but there are authorities, such as Dr. Boulenger, who do not agree that these two are distinct from *T. sinensis*, which being the case it is fairly safe to say that the latter form extends in its range from Canton to the Amur River. The mud-turtles are characterized by their soft, leathery shells, and the complete absence of scales on the limbs or other parts of the body. They are extremely common in our rivers, and are used as food by the Chinese.

In South China and Hainan Island there are two other species of mud-turtle. These are *Trionyx steindachneri* and *Pelochelys*



THE EAST CHINA TERRAPIN (*Geoclemys reevesii*)

cantorii. The former resembles the common form, except that it has pronounced tubercles on the front part of the carapace. The latter is a large, sluggish creature with a blunt head.

All the mud-turtles are very fond of leaving the water in summer and lying basking in the sun on the banks of the rivers or projecting rocks. They are carnivorous and very voracious. The tubercle-covered species are much more highly valued by the Chinese for food than the common species, and they command about five times the price in the market.

The terrapins belong to the family *Testudinidæ*, which includes, as well, the land tortoises. They are characterized by their hard shells, and have the limbs more or less scaled. The commonest species in East China is Reeves'

terrapiu (*Geoclemys reevesii*, Gray), which is abundant in all the rivers and creeks of the Lower Yangtze Basin, as well as of Fukien and Canton provinces. It has been recorded from Tientsin, but as specimens are taken there for sale from the Yangtze Valley, and as during a number of years' residence in the Tientsin district I never once came across this species in a wild state, I am very skeptical about this record. The furthest north I have come across this terrapiu in East China was at San Chieh, on the Tsing-Pu Railway in Northern Anhui. I also came across it in the streams to the south of Sianfu, in Shensi. This terrapiu is not unlike the European pond-tortoise, or terrapiu. It is characterized by three distinct ridges on the carapace, or shell, one down the middle, and one on either side. Its tail is rather long and pointed, while the head is prettily marked with yellow, the general colour being yellowish-grey; brownish on the back.

In South and South-eastern China there are several other species of terrapiu, including the land-terrapiu (*Geoemyda spengleri*, Gm.), while the very peculiar big-headed tortoise (*Platysternum megacephalum*, Gray) is to be found in rivers from Fukien southward. This species has a very flat body, a long tail, and an enormous, strongly-beaked head.

The South China land tortoise, (*Ocadia sinensis*, Gray) extends from the extreme south up to Shanghai. It may at once be distinguished from Reeves' terrapiu by its very much shorter tail. *Cyclemys flavomarginata*, Gray, a land tortoise from Formosa and South China, is characterized by its very smooth shell.

As regards the marine turtles that inhabit the China seas there is not very much data. The Pacific loggerhead turtle (*Caretta olivacea*, Eschscholtz) is common in Japanese waters, and probably finds its way to the China coast. The Japanese green turtle (*Chelonia japonica*, Thunberg) has also been recorded from China, as also has the tortoise-shell turtle (*Eretmochelys squamosa*, Girard). None are at all common, however, and having noted their presence, we may leave them and pass on to our next group of reptiles, the lizards.

There are between twenty and thirty different species of lizard known from China, and their number is continually being added to as research upon the subject progresses. In the last few years several new species have been described from South-western Yunnan, through the activities of the Rev. D. C. Graham, who

has sent large collections of reptiles, amphibians and fishes to the museums in England and America from that area and Szechuan. Quite recently the collections made by the present writer have yielded some new forms, while great things are expected from the collections made and being made by Mr. Clifford Pope of the Third Asiatic Expedition of the American Museum of Natural History.*

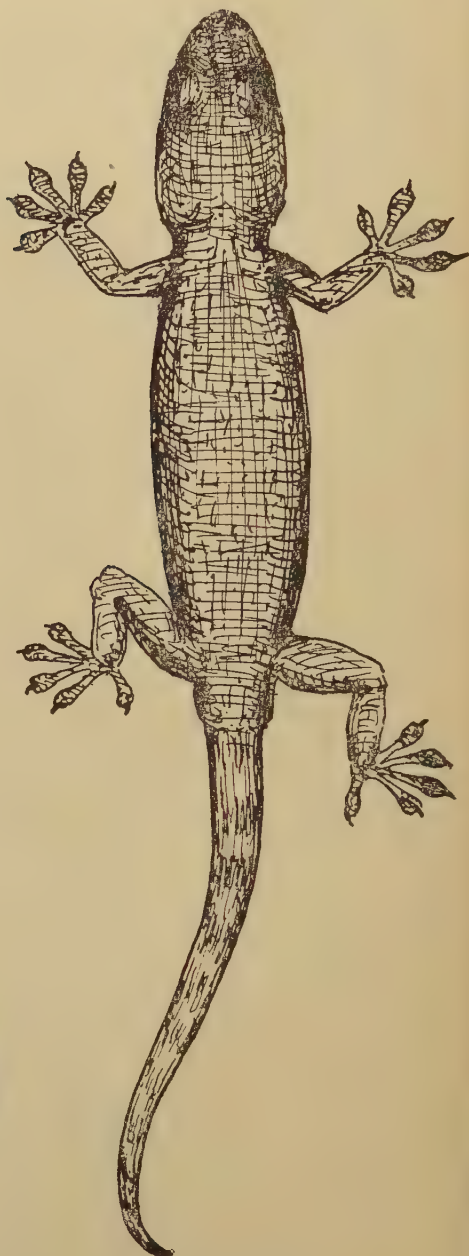
Most people will be familiar with the little wall-lizards, or geckos (*Gekkonidæ*), which are so common in human habitations. Armed with suctoral discs on the toes, these lizards creep about the ceilings and walls of old houses, hiding in cracks, and feeding upon all manner of insects. They have flat bodies and wide, flat heads with prominent eyes. They are all of a dull greyish, brownish, or buff-grey colour, with mottlings of a darker shade, which help to blend their general colour with that of the wall, rock, or even tree upon which they are resting. Three varieties of the common form have been distinguished. One, *Gekko swinhonis*, Gunther, has been described from Peking, and is probably the form that extends thence into the interior of North China. Another, *G. japonicus*, D. & B. is said to have a coastal distribution; while the third, *G. subpalmatus*, Gunther, distinguishable by the presence of a distinct web between the digits at the bases, is the South-east China form. Other interesting geckos are *Peropus yunnanensis* from Yunnan; *Hemidactylus frenatus*, D. & B., ranging from South-eastern China to Yunnan; and *H. bowringii*, Gray, which has been recorded from Formosa and Canton. The last two are much larger than the common geckos.

* Karl Patterson Schmidt in *American Museum Novitates*, No. 157 (Feb. 13, 1925) has recently described one new salamander, one new turtle, four new lizards and ten new snakes from China as follows:—

- | | |
|--------------|--|
| Salamander : | <i>Batrachuperus tibetanus</i> from Titao, S. W. Kansu. |
| Turtle : | <i>Geoclemys grangeri</i> from Yenchingkau, Wanhhsien, Szechuan. |
| Lizards : | <i>Sphenomorphus leveretti</i> from Hainan Island. |
| | <i>Lygosaurus salsburyi</i> from Hainan Island. |
| | <i>Leiolopisma septentrionale</i> from Hsinglungshan, Eastern Tombs, Chihli. |
| | <i>Leiolopisma monticolum</i> from Likiang, Yunnan. |
| Snakes : | <i>Sibynophis hainanensis</i> from Hainan. |
| | <i>Natrix andrewsi</i> from Hainan. |
| | <i>Natrix popei</i> from Hainan. |
| | <i>Natrix helleri</i> from Tengyueh, Yunnan. |
| | <i>Natrix nivalis</i> from Likiang, Yunnan. |
| | <i>Trimeresurus yunnanensis</i> from Tengyueh, Yunnan. |
| | <i>Trimeresurus stejnegeri</i> from Shaowu, Fukien. |
| | <i>Gonyosoma caldwelli</i> from Yenping, Fukien. |
| | <i>Boiga sinensis</i> from Yenping, Fukien. |



THE LONG-TAILED LIZARD
(*Takydromus septentrionalis*)



THE CHINESE GECKO
(*Gekko swinhonis*)

Cosymbotus platyurus, Schneider, a flat-tailed form, occurs in South China. In the mountains of Hainan Island and also on the mainland in Tongkin, a small banded gecko named *Goniurosaurus lichtenfelderi* occurs. Several other forms are known both from the mainland and the islands of Formosa and Hainan.

The next group (*Agamidæ*) comprises the flying lizards (*Draco*) and tree-lizards (*Colates* and *Japalura*) and the toad-head lizard (*Phrynocephalus*). These are very different in appearance from the geckos, having long slender digits, which are not lobed, rather long limbs, less flattened bodies, and very long whip-like tails. Excepting the toad-headed lizard, they inhabit trees, and all are very agile and quick in their movements.

Japalura swinhonis has been recorded from Formosa, and also from Ichang in Central China, *J. splendida* from Szechuan, and *J. yunnanensis* and *J. flaviceps* from Yunnan.



THE TOAD-HEADED LIZARD (*Phrynocephalus frontalis*) from the Ordos Desert

The members of the genus *Draco* are characterized by having a wide membrane on either side of the body supported by extensions of the ribs. These they use as parachutes in vol-planing from branch to branch of the trees in which they live. They are small, beautifully coloured lizards, that frequent the tops of trees, and so are rarely seen. *Draco maculatus*, Gray inhabits Yunnan.

Two forms of *Calotes*, the large oriental tree-lizards, occur in China, one *C. versicolor*, Daudin, being common in Yunnan and extending thence into India, the other *C. maria*, Gray, also occurring in Yunnan, but being less common. These lizards are remarkable for their beautiful colouring and handsome appearance. They are further characterized by the presence of a large crest on

the back of the head and neck. The tail is long and whip-like. Closely related to the foregoing lizards, and belonging to the same family, is the peculiar little toad-headed lizard (*Phrynocephalus frontalis*), which is an inhabitant of the sandy wastes of the Ordos Desert, Mongolia and adjacent parts of North China. These little lizards are of a sandy colour, with mottlings of grey or dusky on the back, and a bright mauve patch on the side of the body just behind the fore limb. They are great fighters and indulge in fierce combats one with another. When angry or alarmed they have a peculiar habit of curling and uncurling their tails rapidly over their backs, or lashing them from side to side. They are very agile and active.

In Yunnan a spiny lizard (*Acanthosaura dymondi*, Boul.) occurs, another species, *A. lamnidentata*, Boul., having been recorded from Fukien. These are far from common.



THE ELEGANT SKINK (*Eumeces elegans*)

A group of very common lizards in China is that comprising the skinks, which belong to the family *Scincidae*. In these the limbs are short and weak and the scales smooth. The commonest are those belonging to the genus *Eumeces*, the so-called blue-tailed lizards. In these the colouration of the young is very different from that of the adult. The young is striped longitudinally dark brown and buff, the tail being bright blue. In the adult, the body and tail are uniformly buff, speckled with scarlet or pink. So different are these two colourations, it was for long thought that two distinct forms of lizard were represented.

The commonest Chinese form is *Eumeces elegans*, which extends from Fukien to Central China. *E. chinensis*, Gray, occurs in South China and Hainan. Recently a species which the writer secured in the Tung Ling (Eastern Tombs) area of North-eastern Chihli—the only place in North China where this genus is known—has been described as new under the name *E. pekinensis*. The more southerly forms reach a comparatively large

size, running up to ten inches in length. These lizards may be found on rocks in valleys or on hillsides, where they love to bask in the sun, hiding, when danger threatens or at night, in deep holes between the crevices.

Other members of the family are less common. One, named *Lygosaurus sowerbyi* after myself by Dr. Stejneger, was discovered in Fukien.* In this the legs are even smaller than in the foregoing, while the sides are dark and the back light brown. It is also very much less common. *Mabuya longicaudata*, Hallowell, has been recorded from South China, *Sphenomorphus indicus*, Gray, from South China as far north as Fukien, and *Leiolopisma laterale*, Say, from Szechuan, Yunnan and East China. It is also found in North America, a rather remarkable fact. Recently the form inhabiting the Eastern Tombs area of North-east Chihli has been described as distinct under the name *L. septentrionale*, and it seems probable that this represents the true Chinese form.

The family *Lacertidæ* (true lizards) is represented in China by two groups. One consists of the long-tailed lizards of the genus *Takydromus*, which are characterized by their slender bodies, strongly keeled scales, which gives the surface of the body a roughened appearance, and, above all, their excessively long tails. In some specimens this appendage is fully three times the length of the head and body, so that the lizard running through the grass looks more like a small snake. The common long-tailed lizard (*T. septentrionalis*, Gunther) ranges throughout East China from Fukien northward. Its place is taken in Manchuria by *T. amurensis*, Peters. A doubtful form, *T. wolteri*, Fischer, has been described from Kiukiang on the middle Yangtze, while recently a new species, *T. intermedius*, has been described by Stejneger from Mount Omei in Szechuan where it was collected by Mr. Graham. All these lizards are of a dull brown colour with a tendency to green

* Leonard Stejneger in Occasional Papers of the Boston Society of Natural History (Vol. 5, pp. 119-121), describes four new amphibians and four new reptiles:

- Amphibia: *Microhyla grahami* from Sui-fu, Szechuan.
Microhyla sowerbyi from Yen-ping-fu, Fukien.
Kaloula rugifera from Kiating, Szechuan.
Polypedates omiemontis from Shin-kai-si, Mt. Omei, Szechuan.
- Reptilia: *Phoxophrys grahami* from Sui-fu, Szechuan.
Eumeces pekinensis from Hsin-lung-shan, Eastern Tombs, Chihli.
Lygosaurus sowerbyi from Futsing District, Fukien.
Takydromus intermedius from Shin-kai-si, Mt. Omei, Szechuan.

on the sides, which is most dominant in the common East China species. They inhabit grassy places, and are very quick and agile.

The last lizard which we have to mention is the sand-lizard of North China and neighbouring Mongolia known to science as *Eremias argus*, Peters. This lovely little creature is not unlike the British common lizard, but is of a light buff or sandy colour marked on the back with rows of eye-like dots. It is to be found in all bare open places, including dusty high roads, where it lies in wait for its prey in the form of insects. It occurs in the sandy areas of the Ordos Desert in great numbers. A doubtful form, *E. brenchleyi*, Gunther, has been described from Inner Mongolia.

Before passing on to the snakes it is necessary to consider briefly two very interesting and uncommon reptiles. These are the Chinese snake-lizards, *Ophisaurus harti*, Boul. and *O. gracilis*, Boul. close relations of our British slow-worm. Of these the former is confined to a small area known as Kautun in the highlands of Fukien on the Kiangsi border, while the latter hails from Yunnan. Thicker than the slow-worm, these legless snake-lizards belong to the same genus as the "*scheltopusik*" (*O. apus*, Pall.) of Russia, Southern Europe, Asia Minor and Turkestan. This remarkable distribution of the genus in the foregoing places and in isolated areas in South-east and South-west China is hard to understand. *O. harti* is of a light buff, or grey-buff colour, with light blue markings. A peculiar groove runs down each side of the body. Little or nothing is known of the habits of this or the Yunnan form.

There are somewhere between ninety and one hundred different species of snake in China, of which by far the greater portion belong to the family *Natricidæ* and are absolutely harmless and non-poisonous. The rest of the species known from China fall into four further families, namely the *Typhlopidae*, or blind-snakes, containing one species; the *Boidæ*, containing the pythons; the *Elapidae* containing the krait, cobra, sea snakes and the like; and the *Crotalidae* containing the various kinds of pit-viper.

It is impossible to go into anything like details regarding all these numerous species of serpent, but we cannot leave the subject without at least discussing some of the more important forms.

The little blind-snake (*Typhlops braminus*, Daudin) is the smallest of all known snakes. It occurs in South-eastern China, whence its range extends through South China, the Malay Archipelago, the Philippines, Guam Island, India, South Africa and

Madagascar. Northward it extends into Japan. This minute snake, measuring not more than four inches in length, looks very much like a worm. There is no thinning down of the neck or tail, the head running into the body and the tail ending abruptly. It is a burrowing form, and may be found while digging or by looking under stones. It is of a dark blackish-brown colour, and only a very close examination will reveal the eyes, mouth and scales. The Chinese say that it curls itself round one's finger and cannot be removed, the finger finally decaying and dropping off. For this reason they greatly fear it.

The largest snake in China is the python, the form found being the Indian python, (*Python molurus*). This handsome reptile ranges as far north as Chekiang and into South-west and Central China. There seems to be some doubt as to the size attained by this python in China, it having been stated that it does not run over ten feet. The writer has heard of fifteen foot pythons in Fukien, while there is a twenty foot skin in the Royal Asiatic Society Museum in Shanghai, probably from Fukien also.

The harmless snakes of the genus *Natrix* are very numerous. The commonest form in the north is the tiger snake (*N. tigrina lateralis*, Berthold). This is a brilliant green form with numerous large scarlet patches down the sides, and certain black marks on the head. It is one of the most beautiful of snakes. It is usually found in the vicinity of water, taking the place in North and East China of the well-known common ringed snake of Great Britain, which it very much resembles except for the presence of the scarlet patches. It attains a length of 5-ft. Its place is taken in the Yangtze Valley and southward by the Chinese ringed snake (*N. annularis*, Hallowell). This also is a beautiful snake. The fishing snake (*N. piscator*, Schneider) is fairly common in South-east China, and may be distinguished from the foregoing by the absence of bright colours or distinctive markings. The four-lined snake, (*N. quadrilineatus*, Boul.) is a beautiful form found in Yunnan, whence several other forms belonging to the same genus have been described.

Next to *Natrix* (or *Tropidonotus*, as it is also called), the commonest genus of harmless snakes is *Elaphe* (or *Coluber*). About a dozen species are known from China, of which the commonest in the north and neighbouring Mongolia is the brown snake (*E. diene*, Pall.), a frequentor of dry areas. The commonest in Manchuria is the Manchurian water snake (*E. schrenckii*, Strauch), which is of a

fine black colour marked below and on the sides with brilliant yellow, and attains a length of upwards of 5-ft. The commonest in the marshy areas of the great plains of North-east and East China is the striped water snake (*E. rufordorsata*, Cantor), which is of a rich light reddish brown colour, with four longitudinal lines down the back, breaking up into dots on the anterior half of the body, and in which species the young are born alive instead of in eggs, due, doubtless, to the fact that the species inhabits swamps, marshes and reed-beds where eggs would have no chance of hatching out. The commonest in the Lower Yangtze Valley and southward is the *E. taeniurus*, Cope, a large, light olive-yellowish coloured snake, with a peculiar black rope-ladder pattern down the back. This latter is not always complete in adult specimens. It reaches a length of 6-ft. or more.

Boulenger a few years ago described two new species of *Elaphe* from Harta (Chih-feng) on the north-eastern border of Chihli and Mongolia. One of these, *E. anomalus*, is very close to the Manchurian *E. shrenckii*, while the other, *E. halli*, is only distinguishable from the brown snake (*E. dione*) by the fact that its scales are keeled.

Between the genera *Natrix* and *Elaphe*, we have two genera of rather small snakes, each containing two or three species known to inhabit China. These are *Achalinus rufescens*, Boul., from South China as far north as Fukien, *A. braconnieri*, Sauvage, from South China, and recorded from East Kiangsi, *Enhydris plumbea*, Boie, and *E. sinensis*, Gray, from South and South-east China, and *E. bennettii*, Gray, only recorded from South China.

Of these *E. plumbea* and *E. sinensis* are the only common forms. They are rather peculiar looking snakes with thick bodies and blunt heads, there being no narrowing of the neck region. They are always found in the vicinity of water.

An extremely common snake in Central and East China is the red and black, or dark green, banded *Dinodon rafozonatum*, Cantor. Next to *Elaphe taeniurus* this is the commonest species in the Shanghai district, as well as the most beautiful, the coral red bands making it very conspicuous. *D. septentrionalis*, Gunther, a Himalayan species, occurs in Fukien. The thin whip-like snake known as *Zamenis spinalis*, Peters, is very common in country places all over China. It is of an olive-brown colour with a

yellowish or cream dark-margined line running the whole length down the middle of the back. This is a very graceful snake.

Two other very graceful serpents are the rat-snakes, *Ptyas mucosus*, L., and *P. korros*, Schlegel, both inhabitants of South and South-eastern China. In these the body is long, slender and whip-like, the head well marked off from the body by a slender neck. They are of a dark brown colour. *P. korros* is the smaller. Both are very swift moving snakes, their favourite food being rats. To obtain these they often frequent human houses.

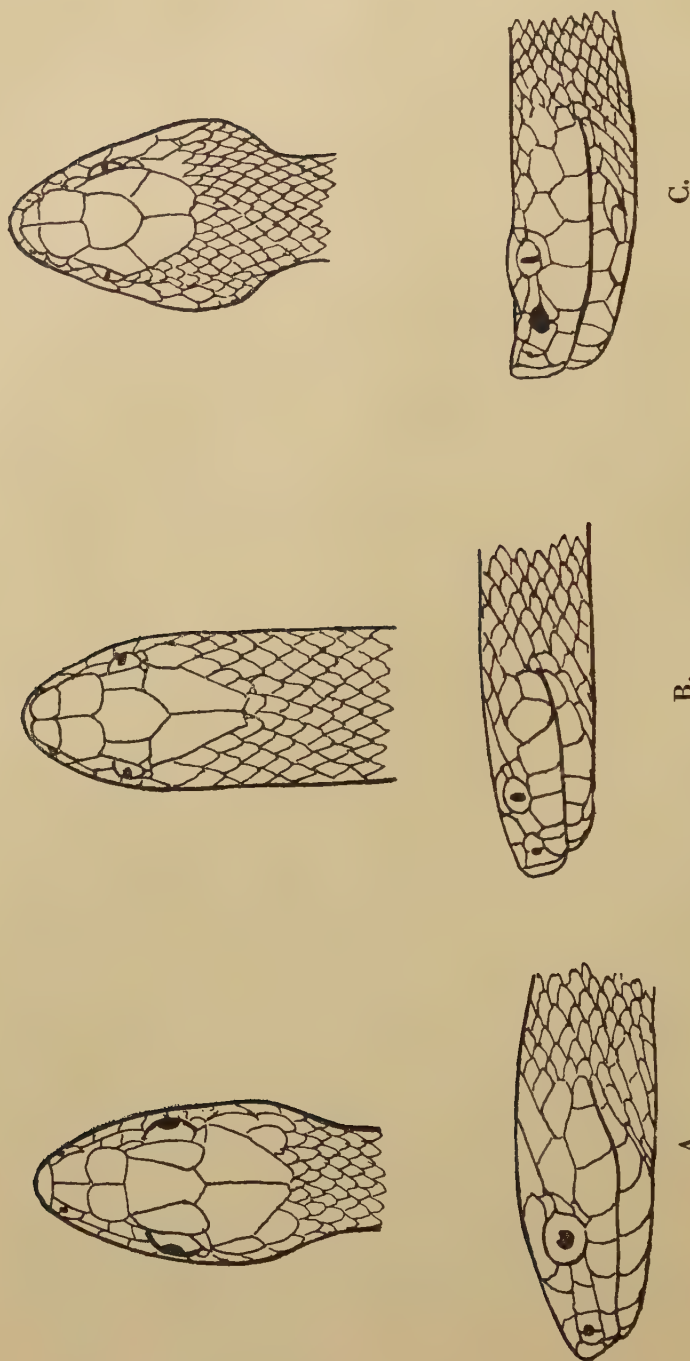
A very large snake, which is related to the foregoing is *Zaocys dhumnades*, Cantor. This species is fairly common from Shanghai to Szechuan and southward. It has been recorded from Si-an-fu, in Shensi.

An interesting snake found in the Lower Yangtze valley region is *Holarchus cyclurus*. It is of a fine buff colour with black bars at intervals across the back, and a black and buff chequered pattern on the underside. *H. formosanus* has been recorded from Formosa, Canton and Hainan.

One of the most beautiful snakes found in China is the slender green snake (*Liopeltis major*, Gunther). This species is of a bright apple green colour above, yellow below. It occurs throughout the Yangtze Valley and southward, being very common in Fukien.

Other genera of natricid snake represented in China are *Ablabes*, *Ophites*, *Tapinophis*, *Thirrhinopholis*, *Macropisthodon*, *Pseudoxenodon*, *Calamaria*, *Psammodynastes* and *Dipsas*. It is impossible to mention the species of each, but we cannot leave these non-poisonous snakes without referring to the two-headed snakes, as the Chinese call them, *Calamaria septentrionalis*, Boul. from Fukien, and *C. berezowskii*, Gunther from Szechuan. These are small snakes in which the tail ends in a blunt point, the whole length of body and tail being about the same thickness. There are markings at the end of the tail like eyes and a mouth, so that without close observation it is difficult to tell the two ends of the snake apart, hence the name. They are greyish in colour with dark and white markings on the sides and under parts.

The night tree-snake (*Dipsas multimaculata*, Schlegel) is common in South China. It belongs to a group of tree-inhabiting snakes with nocturnal habits. *Psammodynastes pulverulentus*, Boie, is a small snake with a wide distribution extending from the



B.

C.

A.

TOP AND SIDE VIEWS OF HEADS OF VARIOUS CHINESE SNAKES

- A. THE TIGER SNAKE (*Natrix*). Harmless
 B. THE CHINESE KRAUT (*Bungarus*). Very poisonous
 C. THE CHINESE PIT-VIPER (*Akistrodon*). Very poisonous
 (Partly after Stejneger)

Himalayas, Assam, Burma, and South-east China to Formosa, and in this connection the reader's attention may be drawn to the close connection between the reptilian faunas of Formosa, Fukien and the Himalayas.

Leaving the harmless snakes we may now consider the poisonous forms. These as already indicated, are divisible into two families, the *Elapidæ* and the *Crotalidæ*. Of these the former is divisible into two sub-families: the *Elapinaæ*, containing the cobras, kraits, coral snakes and masked snakes, and the *Hydrinaæ*, containing the sea snakes.

The question often arises how to distinguish at a glance between poisonous and non-poisonous snakes. The best advice one can give in this regard is not to try to do so, but to treat every snake as if it were poisonous till one has satisfied oneself it is not. But there are a few general rules which may be laid down, and one of these is that the poisonous snakes—except one or two of the sea snakes, which are easily distinguishable, and all of which are poisonous—have short heads. In the case of the cobras, kraits and their relations the heads are small with rounded blunt noses. In the case of the vipers they are heart-shaped, usually with up-turned noses. All the members of the *Crotalidæ* are characterized by the presence between the eye and the nostril of a deep pit, hence the name pit-viper.

The members of the family *Elapidæ* differ from those of the family *Crotalidæ* (and *Viperidæ*) in that the poison fangs are permanently erect; that is to say, they do not lie back when not in use as they do in the vipers.

Probably the most dreaded snakes in the world are the cobras, one species of which, the black cobra (*Naja atra*, Cantor) is to be found in China, ranging throughout the south as far as Wuchang (near Hankow) in the central region and to Hangchow in Chekiang in the east. This is a close relation of the common Indian form. *N. tripudians*. It attains a size of over 5-ft., and is easily recognizable on account of its dark colour and the spreading of the skin in the region of the neck, just behind the head, to form a hood. This species is very common in the Canton district where the Chinese use it for food, and there is a regular snake market. Related to the cobra, but smaller and without the hood, are the kraits, two species of which, *Bungarus multicinctus*, Boie, and *B. semifasciatus*, Kuhl, are known from this country, the former ranging throughout South

and South-eastern China as far north as Kiangsi, and the latter occurring in South China. These snakes are banded black and yellow. They are very poisonous snakes as also is their near relative the masked adder (*Callophis maccllellandi*, Reinhardt), a rather small snake ranging throughout China south of the Yangtze, and of a reddish brown colour banded at intervals on the neck and body and across the eyes with black. Its favourite food consists of the small two-headed snakes (*Calamaria*), which it somewhat resembles in form and habits. The latter fact probably accounts for the reason why the Chinese fear the two-headed snakes so, as they doubtless confuse the two forms.

The sea snakes, of which there are ten or eleven forms that have been recorded from the China coast, are genuine sea serpents, spending the greater part of their lives at sea and only coming to land to breed. They are all characterized by deep, laterally compressed tails, and are usually of a yellowish colour, broadly banded with black. They fall naturally into five genera, namely: *Laticauda*, containing two species that occur in Chinese water; *Disteira*, containing five species; *Lapemis*, one species; *Hydrus*, one species, and *Emydocephalus*, one species.

Hydrus platurus, L., one of the commonest forms, is the only one with a long somewhat flattened head. *Emydocephalus ijimae*, Stejneger, owes its generic name to the fact that its head is shaped somewhat like that of a turtle. *Lapemis hardwickii*, Gray, has a very thick body, while its head, like those of the members of the genera *Laticauda* and *Disteira* is short and blunt. *L. colubrina*, Schneider, and *L. semifasciata*, Reinwardt have the ends of the tails abruptly truncate. *Disteira melanocephala*, Gray, *D. fasciata*, Stejneger, *D. gracilis*, Shaw, *D. cyanocincta*, Daudin, and *D. viperina*, Schmidt, are all characterized by their very deep tails. All these sea snakes have been recorded from the China Seas, but do not occur further north than the coasts of Southern Chekiang, except an occasional stray on the Manchurian Coast east of Korea, whether they have been carried by ocean currents.

The last group of reptiles which we have to consider are the crotalines or pit-vipers, which constitute a large family (*Crotalidæ*) of poisonous snakes that inhabit both the Old and New Worlds, and are characterized by long poison fangs which lie back when not in use, and a pit on either side of the head between the eye and the nostril. In America they are represented by the rattle-snakes,

moccasin-snake, bush-master and fer-de-lance. In China we have some nine species belonging to two genera. These are *Agkistrodon* and *Trimeresurus*, the former with three species of brown, well marked snakes of the halys viper and moccasin-snake type, the latter by six species of bamboo-snake. In all these species the head is very characteristic, being well differentiated from the body, broad at the back, pointed in front, with the nose short and inclined to be up-turned. The last character is more pronounced in *Agkistrodon* than in *Trimeresurus*. The bamboo-snakes may be recognized by their large heads, very slender necks, and the great number of small scales on the head instead of the usual large shields characteristic of all other snakes. The commonest of the bamboo-snakes is a little bright-green species which occurs all over South-east and South China, ranging into India. This is *Trimeresurus gramineus*, Shaw. Of a bright green above and yellowish below, this species has a row of bright red dots down each side. It frequents bamboo groves, where it climbs about the stems and branches in search of its food. It is said to be very poisonous, but, if remedial measures are taken in good time, the victim will recover.

Other species inhabiting China are *T. jerdonii* Gunther, ranging from Assam into West China as far as Ichang; *T. mucrosquamatus*, Cantor, a dull greyish or brownish mottled form ranging from Fukien southward; *T. monticola*, Gunther, from Fukien, Chekiang and Szechuan; *T. yunnanensis*, Schm., recently described from Yunnan; and *T. stejnegeri*, recently described from Fukien.

One of the most formidable snakes in China is the huge Chinese viper, known to science as *Agkistrodon acutus*, Gunther. This is a beautifully marked rich brown and buff species measuring up to 5-ft. in length, and having a large head, armed with terrible fangs fully half an inch in length. It is further characterized by the presence of a distinct snout which protrudes in a remarkable manner, and from which the species' generic name is derived. This dangerous reptile ranges throughout South and South-east China, and northward to Hangchow along the coast and to the Middle Yangtze in the interior.

The only poisonous snake north of the Yangtze Valley is the pit-viper known scientifically as *Agkistrodon blomhoffii intermedia*, Strauch. This is a close relation of the Central Asian and Siberian halys viper (*A. halys*), which it very much resembles. It is beautifully marked with chestnut, dark-brown and buff. A light band

passes from the snout above the eye, a dark one through the eye, while the neck and body are broadly banded and variegated. East China, from Shanghai southward, is occupied by a sub-species known as *A. b. brevicaudus*, Stejneger. In colouring, markings, and general appearance this form is almost identical with the preceding one. These vipers reach a length of about 26 inches, and are very thick in the body, by which feature they may readily be distinguished in the field from other forms of serpent.

Before concluding, mention should be made of an interesting snake which occurs in the northern and eastern parts of Manchuria and in Saghalin Island, but not further south. This is the common European viper (*Coluber berus*, L. = *Vipera verus* of authors), whose range extends from Great Britain in the west to Saghalin Island in the east right across Siberia, and northward to the Arctic Circle.

A similar range is recorded for the European common frog (*Rana temporaria*, L.), and the European common, or viviparous, lizard (*Lacerta vivipara*, Jacquin), so that these three animals may rightly be included in the herpetology of China.

CHAPTER IX.

THE YANGTZE ALLIGATOR.

Some time ago a certain amount of sensation was caused in Shanghai by the capture of an unusually large specimen of the Yangtze alligator in the river off the Bund. Though such animals have from time to time made their appearance in these waters, it seems to come as a great surprise to many people to learn that there are alligators in this part of the world, and one frequently hears doubts expressed as to the veracity of those who lay claim to having seen one of these ugly reptiles in the neighbourhood.

The fact remains, however, that there is a well known representative of the family *Crocodylidae*—to which all crocodiles, alligators, caimans, and gharials belong—to be found in the creeks and marshes of the Lower Yangtze Valley, and its scientific name is *Alligator sinensis*. This fact is interesting enough in itself, but the presence of an alligator in Chinese waters has a geological significance of no small importance, for the simple reason that the only other species of alligator in the world to-day occurs in the Mississippi River basin. To understand the significance of this remarkable distribution it is necessary to examine the geologic strata of Tertiary times, from which it transpires that in those bygone days, between two and three million years ago, alligators inhabited not only Asia, but Europe as well, even the British Islands—which were not island then—having their representatives. It is believed that the whole group of crocodiles and alligators originated in Eurasia, as the two continents may jointly be called, and that the Yangtze alligator is all that is left in the Old World of the sub-group which also contains the South American caimans, near relatives of the alligators. All the other Old World representatives of the *Crocodylidae* must be classified either as true crocodiles or as gharials, the long-snouted, fish-eating members of the family. It is from just such peculiar distributions of animals, past and present, that the formation of bygone ages may be learned, and, in this case, the inference to be drawn is that in Tertiary times Asia

and North America were connected by a broad land bridge, which extended sufficiently far south to allow of such warmth-loving reptiles as the alligators to spread from one continent to the other.

One frequently hears the question asked: What is the difference between a crocodile and an alligator? Apart from certain differences in the skull, which need not be discussed here, the chief differences between these two members of the family is that in the alligator the fourth tooth from the front in the lower jaw fits into a pit in the upper jaw, whereas in the crocodile the same tooth fits into a notch, and is visible from the exterior of the animal's head. Another difference is that the alligators have much broader snouts. The caimans of South America closely resemble the alligators in these characters, but they may be distinguished by certain cranial differences. The gharials are very different from either crocodiles or alligators, since they have very long and slender jaws and snouts, which are armed with numerous and regular teeth. They feed mainly upon fish, but some of the larger specimens are suspected of eating human flesh. They are to be found in the waters of India and Africa.

The chief distinguishing characteristics of the Yangtze alligator appears to be its small size, and this is to be explained by the fact that it represents the last of a once numerous group of reptiles in Asia. But upon this point there is need of more data, for there seems to be no information available as to the full size attained by this species. Up to the present the recently caught specimen appears to be the largest taken, its total length being about six feet. Usually specimens that make their appearance in these parts measure from three to four feet. It would be interesting to know of any other large specimens that have been seen and measured by Europeans.

As regards the distribution and habits of the Yangtze alligator, there is much to be learned. Alligators are known to be mainly swamp inhabiting, where, doubtless, they find an adequate food supply in the more sluggish forms of fish and frogs. In common with the crocodiles, they are prone to undertake long cross country journeys, and it was doubtless one of these travellers that so startled certain gentlemen on the Bubbling Well Road, Shanghai one night some few years ago. Our species occurs in certain swamps of the lower Yangtze, and possibly in most of the large lakes. It is said to be quite common in the Wuhu district, where the Taiping Marsh

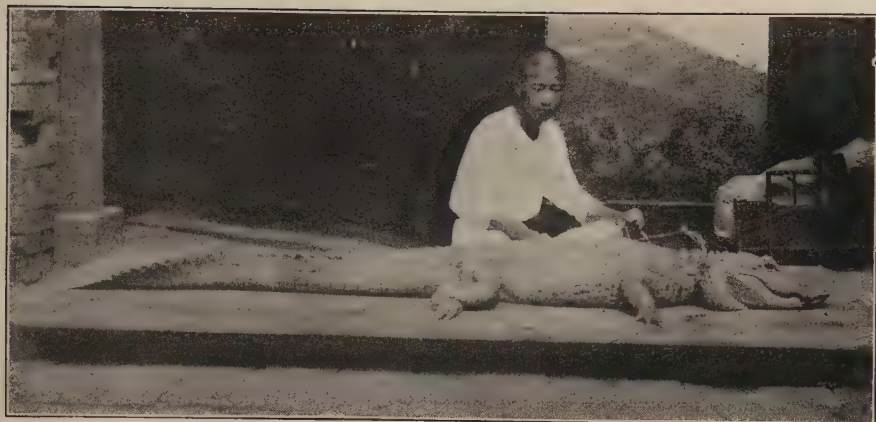


Photo by M. Bruecher

A LARGE SPECIMEN OF THE YANGTZE ALLIGATOR



Photo by R. L. Six

THE GIANT TOAD OF SOUTH-EAST CHINA

A Subspecies of the Asiatic Common Toad, to which the scientific name
Bufo asiaticus gargarizans has been given

forms ideal quarters for such animals. Here the species breeds, and it is possible that those found outside this marsh have been carried out by floods. Mr. Clifford Pope, of the Third Asiatic Expedition of the American Museum of Natural History, tells me that he secured nineteen specimens from a dried swamp not far from Wuhu. Here the alligators lived in burrows excavated by themselves about five feet in depth. Several burrows would converge to a common centre, where the torpid reptiles might be found.

From time to time specimens of the Yangtze alligator have been on exhibition in Shanghai. Not many years ago there were two kept in a tank in the conservatory in the Gardens on the Bund. Another pair was recently on exhibition in the Zoological Gardens in Peking. The Chinese believe these reptiles to be possessed of certain medicinal or magical properties, and dried specimens may not infrequently be seen hanging up in medicine shops.

It is probable that in ancient times the alligator was very much more widely distributed in the Yangtze Basin than it is to-day. There are certain references to it in the classics that suggest this. In the rivers of South China another crocodilian occurs. This is the estuarine crocodile (*Crocodilus porosus*), whose range extends from India to Australia.

CHAPTER X.

THE AMPHIBIANS OF CHINA.

The Amphibians of China have never been written up in a popular way, but this does not mean that these animals are not of very general interest. The word *Amphibia* is derived from two Greek words, *amphi* which means double, and *bio*^s which means manner of living, or life. There is a facetious definition to the effect that an amphibian is an animal that "can't live in water and dies on land." This is suggested by the life-history of the average amphibian, which spends part of its life as a purely aquatic animal breathing by means of gills, and part as a land animal breathing by means of lungs. Joking aside, however, amphibians may be defined as cold-blooded vertebrates which have two distinct stages in their life histories: one an aquatic larval stage when breathing is by means of gills; the other an adult terrestrial or semi-terrestrial stage when breathing is by means of lungs.

The chief difference between amphibians and fish lies in the formation of the limbs, these being the regular five-toed (pentadactyl) type of most terrestrial vertebrates in the amphibian and many-rayed fins in the fish.

From reptiles, amphibians differ in having the aquatic larval stage, and also in the complete absence of scales or horny plates of any kind.

Amphibians fall naturally between the fishes on the one hand and reptiles on the other, but this does not necessarily mean that they represent a stage in the evolution of the reptiles from fish. It is more likely that reptiles, amphibians and modern fishes all sprang from a common generalised and very primitive ancestor that inhabited the seas in some Pre-Carboniferous period of the earth's history.

Geological records show that amphibians were well established in the Carboniferous period, when they existed in great variety and profusion, some attaining a very large size. At this period they were probably the chief inhabitants of the great swamp-

forests, which appear to have offered just the right environment for the development of the mode of life and physical form of the typical amphibian.

The life history of the typical amphibian is divisible into three stages, namely :

1. The Egg Stage

The egg is generally laid in water. There are several notable exceptions, such as that of *Rhacophorus*, the flying frog, in which the eggs are laid in a mass of froth suspended from the limb of some tree overhanging water. When the young hatch they drop into the water and carry on the normal existence. Another exception occurs in *Pipa*, or the Surinam water-toad, in which the eggs are deposited in lidded receptacles in the flesh of the mother's back. An interesting case is that of the midwife-frog, in which the male commandeers the strings of eggs as the female lays them, and winding them about his legs cares for them till the tadpoles hatch out. In the worm-like amphibian of Ceylon, known as *Ichthyophus glutinosus*, the female makes an underground chamber, where she lays her eggs, subsequently coiling round them to protect them. The female of a certain South American species of tree-frog (*Nototrema*) carries the eggs in a sack on her back. Another small South American frog, known as *Rhinoderma darwini*, is remarkable in that the male carries the eggs in a huge pouch that occupies the whole of the underside of the body, the eggs apparently being taken in through the mouth. In nearly all cases where the eggs are not laid in water, the tadpole stage is missed out and the young hatch out of the egg in the fully adult form.

2. The Tadpole Stage.

The majority of amphibians go through an aquatic larval stage when they are known as tadpoles. At this time they are more or less fish-shaped, having a long tail with vertical fins and external gills. In due course limbs appear, the gills disappear into gill-slits on the side of the head, and in the case of frogs and toads the tail is absorbed. When the gill slits close and lungs have developed the amphibian leaves the water. Some forms, however, never leave the water. Such are the eel-like *Amphiuma* of America, which has minute three-toed legs, the *Proteus*, found only in subterranean springs in Europe and America, and having a long, whitish body and no eyes, and the siren salamander of North America, in which only the two

front legs exist. In all these forms external gills persist throughout life. In the remarkable Mexican form called the *Axolotl*, or tiger salamander, the larval stage persists as long as there is plenty of water. If the pond or stream in which the animal lives begins to dry up, the tadpole at once begins to metamorphose into an adult, gill-less, air-breathing terrestrial form. The adult stage has also been produced by feeding the tadpole with thyroid extract.

3. The Adult Stage.

The adult amphibian generally lives on land, repairing to water only for spawning purposes. Some, however, such as the giant salamanders of China and Japan, live in water all their lives. Some peculiar worm-like forms live underground. Other forms, such as the *Siren*, *Amphiuma* and *Proteus*, live in a semi-adult form all their lives in water.

The amphibians are divided into two main groups.

1. The *Urodela* (or *Caudata*), amphibians with tails in the adult stage, *eg.* salamanders, newts, etc.

2. The *Anura* (or *Salientia*), amphibians in which the tail disappears in the adult, *eg.* frogs and toads.

The amphibians of China are fairly well-known. Some forty or fifty species have been described up to date, but it is probable that there are many more waiting to be discovered.

China is not rich in *Urodela*, or tailed amphibians. Probably the most interesting of Chinese tailed amphibians is the giant salamander. This was first known from Japan, under the name *Megalobatrachus japonicus*. A Chinese form was described by Père David, the famous French missionary-naturalist, who secured a specimen in South Shensi. This has been said to be the same as the Japanese form. A new species has been described recently from Hongkong, and named *M. sligoi* after the Marquis of Sligo, who presented it to the London Zoological Gardens. Some live examples secured by me recently in Shanghai probably represent the same form, as they come from Canton Province, the new species probably also being a mainland form.

The earliest record of this type of giant salamander is from the Miocene strata of Switzerland, and was described by the finder as a fossil man.

Several kinds of, smaller salamanders and newts occur in China. It is a remarkable fact that newts and their kin are found in Eastern and Southern China but not elsewhere in Asia south of

the central desert belt. They are not found in Africa. This has been explained by suggesting that the desert belt has formed an impassable barrier to the southward migration of this type of amphibian, which originated in the northern part of the Eurasian land mass. Amongst the smaller salamanders and newts there are some very interesting forms. Probably the most interesting to zoologists is the genus *Hynobius*, only one species of which has been described from China, the rest being mainly Japanese. This solitary species is *Hynobius chinensis*, Guenther, and it was described from Ichang in Central China. It is far from common. *H. leechii* has been described by Boulenger from Korea. The hynobiids are long, rather slender salamanders, usually of a dull mottled appearance, with long laterally compressed tails. They run about eight inches in length.

A much smaller salamander, known to science as *Salamandrella keyserlingii*, a Siberian form, has been recorded from Manchuria and Szechuan. In this the tail is comparatively short and less deep than in the foregoing.

An interesting spotted form is found in streams in the highlands of Central Fukien, in South-east China. This is known as *Pachytriton brevipes*. In life the upper parts are a rich brown scattered with almost black round dots. The lower parts are yellowish or orange. The tail is long and compressed. In South-west China the peculiar warted triton, *Tylotriton verrucosus*, is found, as well as a species of newt named *Diemchtylus wolterstoeffii*. The latter is replaced in the east by the common Chinese newt, *D. orientalis*, which is dark brown above, orange-yellow below marbled with dark brown. Another form recorded from Ningpo and Canton has the under parts blue-black with orange spots. This is *D. sinensis*.

Geomolge fischeri, a little known newt, has been described and recorded from the Ussuri Valley in Manchuria. It is slender in form, with a long tail.

The tailless amphibians are represented in China by a great variety of frogs and a lesser number of toads. The true frogs, that is to say, tailless amphibians with teeth in the upper jaw and a firmisternian shoulder girdle, are best represented. The giant frogs of the high mountainous areas of the south-eastern provinces are the largest, approaching, as they do, the American bull-frogs in size. One of these is known as *Rana kuhli*, D. & B. This is a



A. THE MANCHURIAN NEWT (*Geomolge fischeri*)

B. THE SIBERIAN SALAMANDER (*Salamandrella keyserlingi*)

C. THE WEST CHINA SALAMANDER (*Hynobius chinensis*)

(About natural size : A. and B. partly after Stejneger. C. from life)

monster species of a dark colour above, whitish below, with characteristic bony tubercles on the chest of the adult. It lives in rocky ravines high up in the mountains, and is a very predacious creature, feeding readily upon its smaller relations and even its own offsprings. I found it fairly common in Central Fukien. *R. boulengeri* is another closely related form from the Ningpo area of Chekiang.

Another large frog is the Chinese tiger frog (*R. tigerina*, Daudin), an olive-green or brownish-yellow form, the skin of whose back is strongly warted. There are practically no markings in this species. It is common throughout Central and South China, being prevalent in the rice-fields and ponds. Next in size comes the Chinese edible frog (*R. nigromaculata*, Hallowell), which is very closely related to the European edible frog (*R. esculenta*). It may readily be recognised by its bright green colour, strongly marked sides and long, strong legs. The commonest frog in the east and south is *R. limnocharis*, Wiegmann. This is a rather smaller species than any of the foregoing, and is remarkable for the great variety of its colouring and markings. It is usually of a mottled grey colour, with a light buff streak down the middle of the back, while the skin of the back is warted. The back streak may be light chestnut in colour, broad, narrow or entirely absent, while the mottlings on the back may be light chestnut, buff, or even bright green. This is the species that is commonly met with in almost any environment at all suitable to frogs.

Very much less common are what may be called the wood frogs. In these the hind legs are long and slender, while the general colouring is usually brownish, tinged with pink or pinky-buff. In some the skin is almost flesh-coloured. The hind legs are usually strongly banded with a darker shade, while a dark band passes from the snout along the side of the head, enveloping the eye. These graceful frogs usually occur in wooded or well-shaded areas. The North China form is *Rana amurensis* Boul., its range extending from the Amur into Chihli and probably further west. The common European frog, *R. temporaria*, extends from England across North Europe, and Siberia into Northern Manchuria and Saghalin Island. Many other members of the genus *Rana* occur in China, but this is not the place to discuss them in detail.

Mention has already been made of the tree frogs of the genus *Rhacophorus*. These are all southern in their distribution. The

largest and most handsome species is the giant tree frog (*R. dennysii*, Blanf.), a close relation of the flying frogs of Java and other tropical islands. This fine frog is of a brilliant green colour above, cream below, with markings on the back exactly resembling rust-mould on leaves. It thus resembles a leaf, and is almost impossible to see when in a tree. It is characterized by having suction discs at the tips of the long fingers, by means of which it climbs trees with the agility, almost, of a monkey. The webs between the fingers and toes are said to act as parachutes when extended, and greatly to assist the frog in its long leaps from one branch to another. It is members of this genus that lay their eggs in a nest of froth at the end of a branch over some stream, by which means they are safeguarded from enemies and kept moist as well as well aerated till they hatch out. Occasionally specimens of this large tree-frog are of a beautiful violet colour instead of green. In spring the small but penetrating and pleasant sounding call of this frog may be heard coming from every bush and tree in the areas it occupies, but seldom does one get a glimpse of the caller.

Besides this large species there are several smaller forms of tree-frog, belonging to the genus *Polypedates*. These are mostly mottled brown or grey in colour, and are far from common. Other forms of tree frogs are *Oxiglossus lavis* and *Ixalus kakhienensis*, And., from South and South-west China. The members of the genus *Oxiglossus* differ from those of *Rana* in the absence of any notch in the tongue and of vomerine teeth. *Ixalus* is very close to *Polypedates*.

Between the tree frogs and the toads we have three groups of tailless amphibians. The first of these includes the small tree-frogs or tree-toads of the family *Hylidæ*. These are beautiful little creatures, usually of bright green upper parts and light lower parts. They have knobs at the tips of all their fingers and toes and are expert climbers. The form common to South and South-eastern China is *Hyla chinensis*, Guenther, and is characterized by its yellow sides strongly marked with black. An unspotted form, *H. immaculata*, Boettiger, occurs in the Lower Yangtze Valley, Manchuria and Southern and Eastern Mongolia, while *H. stephensi*, Boul., is found in Korea and Manchuria. This form is marked down the sides, but has no yellow colour. These tree-toads are remarkable for the extraordinary noise they can make when calling, which they do with considerable vigour during the night and on

rainy days. They make far more noise than the very much larger tree frogs of the genus *Rhacophorus*. When calling they swell the skin of the throat out like a bladder, in much the same way that the large members of the true frog family, *Ranidæ*, do the sacks situated at the sides of the neck.

Next to the tree-toads come the members of the family *Microhylidæ*. These are very small, fat-bodied, sharp-nosed toad-like creatures, which are to be found only on the ground in country districts. They are brown in colour, with markings of a slightly darker colour. They are less than an inch in length. The species



THE CHINESE TREE-TOAD (*Hyla chinensis*)
(Enlarged)

THE PIGMY EROG
(*Microhyla sowerbyi*) of Fukien.
(Considerably enlarged)

occupying Fukien, where it is fairly common, has recently been named *Microhyla sowerbyi* after the writer who first discovered it.

Closely related to the toads, but differing in some particulars are the so-called fire-bellied frogs, which belong to the family *Discoglossidæ*, or disc-tongued frogs. These are characterized by the very warty nature of their skins, in which they resemble the true toads, and by their bright colours, the whole of the under side being of a bright orange-red marbled with black. There are two forms known to China, one a rather small form called *Bombina orientalis*,

Boul., occurring in Manchuria and in North Shantung, and the other a much larger form called *B. grahami*, Boul., from Yunnan, where it was recently discovered by the Rev. R. C. Graham, after whom it was named. These frogs or toads are very toad-like in general shape, but differ in having no external tympanium or eardrum. They have a peculiar habit when alarmed of turning their arms and legs over their backs so as completely to disguise their usual appearance. The only places I have ever seen *B. orientalis* were on the banks of the Yalu River in South Manchuria and North Korea, and at Chefoo. This species has the upper parts dark green with blackish markings.

Finally we have the true toads, members of the family *Bufo*nidae. There are three common species in China. Of these the largest is the Asiatic common toad (*Bufo asiaticus*, Steindachner), which closely resembles the common European form. It extends from the Amur to Shanghai, south of which place it is replaced by a closely similar form, *B. gagarizans*. The second form common to North China and neighbouring Mongolia and Manchuria is Radde's toad (*Bufo raddei*, Strauch), which is a beautifully marked species, somewhat smaller than the common toad. It is dull olive-brown, with dark mottlings edged with chocolate-brown. This species is found even in the Ordos Desert. It takes the place in these parts of the well-known natterjack toad of Europe.

In South China, ranging as far north as Chekiang, a peculiar toad, which may be called the black-pencilled toad (*B. melanostictus*, Schneider), is very common. It may at once be recognized by the peculiar black pencilling of the ridges about the head and mouth, the black tips to the fingers and toes, and black points to the warts on the body. Otherwise it is like the common toad but is not so large.

This by no means exhausts the subject of Chinese amphibians, but it will be seen from this account that the country is well represented by this group of vertebrates, while the fact that new species are continually being described shows that much work remains to be done upon them.

CHAPTER XI.

THE GIANT SALAMANDER OF CHINA.

Every now and then the residents of Shanghai are regaled with accounts of remarkable creatures taken from the Whangpoo and adjacent creeks, or making their appearance on the streets by way of the drains, and a discussion usually follows in the papers as to whether these are lizards, alligators or salamanders. To judge from the accounts of those who are fortunate enough to see these animals, they might be any of the foregoing, while it not infrequently happens that specimens of geckos and other lizards are actually sent to the local museum by enthusiasts who have mistaken them for young alligators or salamanders. As a matter of fact, the Chinese giant salamander has actually been taken from the Whangpoo and adjacent creeks, and specimens may be seen in the Royal Asiatic Society's museum which were captured locally. In a country which contains many very remarkable animals the giant salamander is in the foremost ranks of interesting species. The fauna of China and adjacent areas is, in many ways, unique, owing to the presence of just such peculiar creatures as this, so that an account of the latter, its habits and distribution, is not out of place.

Salamanders belong to the order *Urodela* or *Caudata* of the class *Amphibia*. There is no need to go into a very detailed discussion of these divisions, but it may be stated, in passing, for the sake of the uninitiated, that the amphibians are now considered as a separate class of vertebrates, intermediate between the reptiles, on the one hand, and the fishes on the other. The larval stages of amphibians is spent in water, and at such time the young amphibian is physiologically a fish, having a tail, median, unpaired fins (which, however, are never rayed as in fish) and gills. In many cases the adult amphibian is physiologically a reptile, having walking legs, breathing through lungs, and living upon land. The great difference between the adult amphibian and the reptile is that the latter is covered with epidermal scales, while the skin of

the former is porous, soft, and generally contains glands which keep it moist. There are other internal skeletal as well as embryonic differences which need not be mentioned here.

The *Urodela* or *Caudata* are those amphibians which possess tails in the adult stage as opposed to the order *Salienta*, containing the frogs and toads, in which the adult has no tail. To the *Caudata* belong the salamanders and newts, and the order is divided up into a number of families, namely :

Salamandridæ, the terrestrial salamanders and newts.

Amphiumidæ, the four-legged, aquatic salamanders, in which in the adult stage external gills are absent,

Proteidæ, containing the four-legged aquatic salamanders in which the external gills persist throughout life,

Sirenidæ, comprising two-legged aquatic salamanders in which external gills persist throughout life, the family being represented by but two genera, each containing a single species.

The giant salamanders belong to the order *Amphiumidæ*, which contains but three genera, two of which are confined to North America while the third—the one under discussion—is now only found in China and the Japanese Islands. A considerable amount of controversy has taken place as to whether the Japanese and Chinese forms are distinct; up till quite recently the majority of modern zoologists having come to the conclusion, mainly, it may be suggested, owing to the lack of comparative material, that they represent but one species to which the name *Megalobatrachus japonicus* rightly belongs, though it has not infrequently been referred to, especially in popular writings, as *Megalobatrachus maximus*. The confusion of names occurs owing to the fact that Temminck and Schlegel, two naturalists who worked extensively upon the fauna of Japan, described the species independently of each other in the same year, Schlegel's name, *Salamandra maxima*, having been published on September 5, 1837, and Temminck's name, *Triton japonicus*, on July 8. The use of the generic name *Megalobatrachus* is also not infrequently called in question, some zoologists preferring to use *Cryptobranchus*. This, however, rightly belongs to the hell-bender of the Mississippi, *Cryptobranchus lateralis*, to which the giant salamander is so closely related that by some the two forms are placed in the one genus under the name *Cryptobranchus*. The

hell bender, however, is smaller than the giant salamander with a proportionately smaller head and larger eyes, while there are other minor differences which need not concern us here.

It is interesting to note the remarkable distribution of these two members of the family *Amphiumidæ*, since it coincides with that of the alligators which are known to occur only in the lower Yangtze Basin and the Mississippi River and its tributaries. These are not the only cases of affinities existing between members of the fauna of the Eastern States and China, others being the peculiar beaked sturgeon, *Psephurus gladius*, from the Yangtze, whose nearest relation is the spoon-beaked sturgeon (*Polyodon folius*) of the Mississippi, and the katy-dids of the genus *Atlanticus*, of which several species occur in the Eastern States and adjacent Canada and one species in South-eastern China. As regards the giant salamander it is interesting to note that the earliest geological record of the group occurs in the upper Miocene of western Europe, skeletal remains having been found and described in the year 1726 under the name of *Homo diluvii testis*, the describer, Dr. Scheuchzer, being under the impression that they represented the remains of a human being buried during the Noachian Flood.

The Chinese giant salamander was originally described as distinct from the Japanese form, under the name *Sieboldia davidiana*, having first been discovered by the famous naturalist, Père Armand David, in South-western Shensi. Since, however, it is now considered to be identical with the Japanese form, this name can no longer be applied. In Japan the giant salamander is found only in small mountain streams, where it hides in cavities under the banks or in the thick weeds and aquatic plants, and for long it was supposed that the same habitat was adhered to by the Chinese form, i.e., the latter was considered to be an inhabitant only of mountain streams. This appears to be erroneous, since, as already shown, specimens occur in the muddy waters of the Whangpoo, while the writer has received a report of the taking of a specimen in the marshy areas on the Chihli plain.* The accompanying photograph, which was taken by Mr. E. F. S. Newman of the Postal Service, is of an enormous specimen that

*Recently E. Licent has published in his book "Dix Années d'Exploration dans la Bassin Du Fleuve Jaune," a statement that a giant salamander taken from the Pai Ho was sent to him. (See Vol. I, p. 115, pl. 11, Fig. 7.)

was taken in Kweichow province, in the Chin Ho, near Kwei-yang Fu. This specimen measures five feet, nine inches from the tip of the nose to the tip of the tail, which, as far as can be ascertained, beats all previous records, the average length of the salamanders known up to date being about three feet.

Recently, a new species of giant salamander has been described from Hongkong under the name *Megalobatrachus sligoi*, having been named after the Marquis of Sligo, who presented a specimen to the Zoological Society of London. Mr. Boulenger, the describer, states that he believed the specimen to have come from the mainland. Since this description was published, I secured a number of specimens, probably of this species, from a Cantonese delicatessen shop in Shanghai, the proprietor informing me that they came from the mountain streams of Canton Province. This throws doubt upon the origin of the specimens taken in the Soochow Creek, which might have been escapes from this or a similar shop. Whether this new form is identical with that from Central and West China remains to be ascertained.

In general appearance resembling the common newt of Europe, the giant salamander has the whole of the body warty; the head is enormous and very depressed, the mouth is very wide, the eyes extremely small and placed on the top of the head. The legs are small and weak, there being four toes in the front feet and five in the hinder feet, the outer edge of each of the limbs being slightly webbed. The tail is long, deep, and laterally compressed, and the animal propels itself through the water by rapid lateral strokes of this appendage. In colour the giant salamander is of a dull, speckled brown, sometimes almost black. It is an extremely ugly creature, not to say fearsome in its appearance, but is harmless, except that it can bite with considerable force. Its food consists of worms, fish, and other amphibians. In habit it is very retiring, and only comes out into open water at night in search of food. It may be taken on a line, in which manner the large specimen from Kweichow was captured.

The form described from South China differs from the Japanese form in having a more depressed head, with less pronounced tubercles. The Chinese consider it very good eating. When handled it makes a peculiar cry like that of a new born infant, for which reason the Chinese popular name is *Wa Wa Yü*, or "child fish." It is also known as the *Na Yü*.



Photo by B. T. Prideaux

THE CHINESE GIANT SALAMANDER

A specimen purchased in Shanghai, and said to have been brought from Canton



THE CHINESE WELS, OR SHEAT-FISH (*Parasilurus asotus*) AND THE YALU
SLENDER CAT FISH (*Pseudobagrus emarginatus*)

The eggs of this amphibian are rather large, each embryo being contained in an elongate capsule of jelly-like substance, the capsules being strung one after another like a string of beads. A large number are laid. A living specimen, which was kept in an aquarium in Amsterdam, laid as many as five hundred in one season. The female is said to envelop herself with the chains of eggs; thus protecting them, and by moving through the water assuring an adequate supply of oxygen to the developing embryos. As a matter of fact, opinions differ as to whether this action is performed by the male or female, the Japanese naturalist, Ishikawa, maintaining from observations made in nature that it is the female, while Kerbert, who observed the captured specimens in the Amsterdam aquarium, concluded that it was the male.

As regards the development of the young giant salamander, it is probable that the gills disappear at a very early stage, since, up to date, none have been found with these showing.

The distribution of this species in China has not yet been definitely worked out. Judging from the fact that specimens have been actually recorded from southwestern Shensi, the lower Yangtze, from Kweichow province and now from Canton and Hongkong, it would appear to be somewhat extensive. Unfortunately, collected material is not plentiful so that it is almost impossible to decide whether more than one species occurs, and it may be suggested that when adequate series from all parts of China have been made the presence of more than one species may be established.

CHAPTER XII.

THE FRESH-WATER FISHES OF NORTH CHINA.

Interest has been roused of late years in the subject of the fresh-water fishes of China by letters appearing in the *North-China Daily News* relating to the art of angling. From these it may be gathered that a certain amount of confusion exists in the minds of anglers and laymen alike upon the identity of the species that occur in the vicinity of Shanghai and in China generally.

The burning question of fly-fishing is raised, and whether or not there are any species to be found in the waters round Shanghai that will rise to a fly. It is even asked whether there might not be some form of true "game fish" in the hilly and mountainous areas within easy reach of that Treaty Port; while Mollendorff is quoted as having definitely located the spotted brook trout in certain waters of Chihli, where he enjoyed good fishing.

For the sake of those desiring information upon the subject it is proposed here to give an outline account of the fishes of China, their relationship to those of other countries, and their present distribution, at the same time bearing in mind the requirements of devotees of the rod and line and fly, and the possibilities in China of sport such as is enjoyed in other countries.

But before going into such details the point may be emphasized once more that the reason why good fishing is not usually to be had in China is that the Chinese themselves go in for fishing in far too intensive a manner, the result being that the denizens of the lesser water ways, where alone the angler might reasonably expect to obtain the sport he seeks, are rendered altogether too shy to be tempted. Such large fish as do occur owe their very existence to their caution or cunning in avoiding the ubiquitous Chinese fisherman, and it is not likely that they are going to succumb to the wiles of a European sportsman, be he never so adroit.* It is only

*Doubt is cast on this theory by the well-known sportsman, Major Percival Lea Birch, whose recent experiences, described in *The China Journal of Science and Arts*, and *The Field*, suggest that large fish in Chinese waters are not difficult to take if due care is exercised in the selection of bait, tackle, etc. He claims that they are not nearly as sophisticated as large fish in Europe and India.

in the deep waters of the larger rivers and lakes that sizeable and unsophisticated fish, such as might easily be taken in the approved sporting manner, are to be found. Sometimes, however, these large fish are carried by floods across country, and as the waters subside find themselves in canals, creeks, small streams or even in ponds, and it is then that those keen on fly-fishing and angling generally might try their luck with the best prospect of success. Such was certainly the case in the vicinity of Tientsin, for after the great flood of 1917, various local enthusiasts made some fine catches of really large fish in the creeks and ponds round the Race Course, which fish had undoubtedly been left there by the flood waters. It may here be mentioned that the late Mr. R. K. Douglas and others have had very good fly-fishing in these same waters, fish of quite a good size having been taken in this most sporting of ways.

In considering the fresh-water fish of China it is necessary to pass under review the members of some eleven families, only a few of which, however, contain species that will appeal to the angler pure and simple, but all of which must prove of interest to the nature lover. Taking them in the order usually assigned to them by systematists they are :—

1. *Acipenseridæ*, containing the Sturgeons.
2. *Salmonidæ*, containing the Salmon, Trout, Chars, Vendace, Whitefish, Pollan, Grayling, and other "game fish."
3. *Cyprinidæ*, containing the Carp, Gudgeons, Minnows, Bitterlings, Dace, Chubs, Roaches, Culters, Breams, Loaches, and so on, too numerous to mention.
4. *Siluridæ*, containing the Catfishes.
5. *Anguillidæ*, containing the Eels.
6. *Esocidæ*, containing the Pikes.
7. *Gasterosteidæ*, containing the Sticklebacks.
8. *Ophiocephalidæ*, containing the Serpent-head.
9. *Serranidæ*, containing the Chinese Perches, or Fresh-water Basses.
10. *Cottidæ*, containing the Miller's Thumbs, or Bullheads.
11. *Anabantidæ*, containing the little Paradise Fish.

Of these by far the most important and most numerous represented in Chinese waters are the *Cyprinidæ*, or, as they may be popularly called, the members of the carp family. In all the rivers and streams of this country this type of fish predominates in num-

bers of species if not in actual individuals over all other kinds put together.

The true sturgeons may be dismissed after mentioning that there are two forms, *Acipenser shrenckii*, and *Huso dauricus*, to be found in the basin of the Amur River, and neighbouring waters of Manchuria, and one, *Acipenser sinensis*, in Chinese waters as far south as Canton. The Yangtze beaked sturgeon (*Psephurus gladius*) is found in the Yangtze River, as the name indicates.

The most interesting fish to all anglers are, of course, the members of the *Salmonidæ*, since they alone can be looked upon as "game fish." But, alas! the hopes of those who would see this type of fish in the streams of the mountains and hills of the South-east China hinterland are vain, unless it be found that the peculiar salmonoid known to science as *Plecoglossus altivelis* really does inhabit the region of Fukien and Chekiang. This is a species that resembles nothing so much as a char, but it has very distinctive teeth. It is an inhabitant of the streams of Japan, Formosa, Korea, and the South Manchurian and North-east Chinese coasts. It ascends the small streams and rivers that empty directly into the sea in order to spawn, in just the same way as does the salmon, and at such times is easily taken with a net. It would probably take a fly. The reason for mentioning it here is that recently the British Museum received an acquisition of fishes said to have come from the Fukien region, and in it were some members of this species. So it seems possible, and indeed it is only reasonable to suppose, that a true "game fish," a relative of the European chars, is to be found in the mountain streams of South-east China.

The only other true fresh-water salmonoid hitherto discovered in China proper, is that reported by Mollendorff from Chihli Province. But it may be stated definitely that this was not a brook trout, and that Mollendorff was wrong in supposing it to be such. It is an interesting species that is intermediate between the true trout and the vendace, or whitefish. Its name is *Brachymystax lenok*, and its range extends from the Baikal region eastward through the Amur and southward through Manchuria into North-eastern Chihli, where in the clear mountain streams of the Tung Ling area it is still to be found, though becoming increasingly rare. Mollendorff is to be forgiven for mistaking the identity of this fish, for it is extremely like the British brook trout (*Salmo trutta*) in its shape, colour, and markings. It has no red spots, however,



THE CHINESE STURGEON (*Acipenser sinensis*)

being speckled with black only. This fish readily takes a fly, and in Manchuria, where it is very common in some parts, the writer has seen the Koreans and Chinese catching it with an improvised fly of red and white silk. It reaches a large size, fully grown specimens looking more like salmon. It is said that a weight of 30-lbs. is attained by this fish in Siberia.

In order to understand why the *Salmonidæ* do not occur more plentifully in China, it is necessary to take a look at their history and distribution, past and present. The whole group is northern in its origin, not to say Arctic. In Tertiary times they enjoyed a wide Arctic distribution, and it was then that the Asiatic, European, and North American forms became differentiated. Subsequently all these northern forms were driven south by the Polar ice-cap of the Glacial epoch, but they followed the retreating ice in Post-glacial times, and regained to a large extent their former range. Being northern fish, and fond of clear water, China with its southerly latitude and muddy waters could not support them, and so they have ceased to exist there. One of the great areas congenial to the *Salmonidæ* is Siberia, to which belong the Amur region and part of Manchuria, and here we find these fish not only numerically strong, but also very varied. There are some twenty-six different species of salmonoid fish known to occur in Siberia, of which six or seven occur also in the Amur and Manchurian region while the latter boast three additional forms. Amongst these are the migratory salmon of the genus *Oncorhynchus*, that swarm up the rivers of both the eastern and western shores of the North Pacific in countless numbers. If Manchuria is to be looked upon as part of China then these salmon, as well as the Eastern grayling (*Thymallus grubei*), the three chars, *Salvelinus alpinus*, *S. leucomaenis*, and *S. taimen*, and the two coregonoids, *Coregonus chadary*, and *C. ussuriensis*, must be included in the list of Chinese fishes. The two species of salmon that are known to occur in Manchurian waters are *Oncorhynchus gorbuscha* and *O. keta*, while the occurrence of *O. nerka* is suspected.

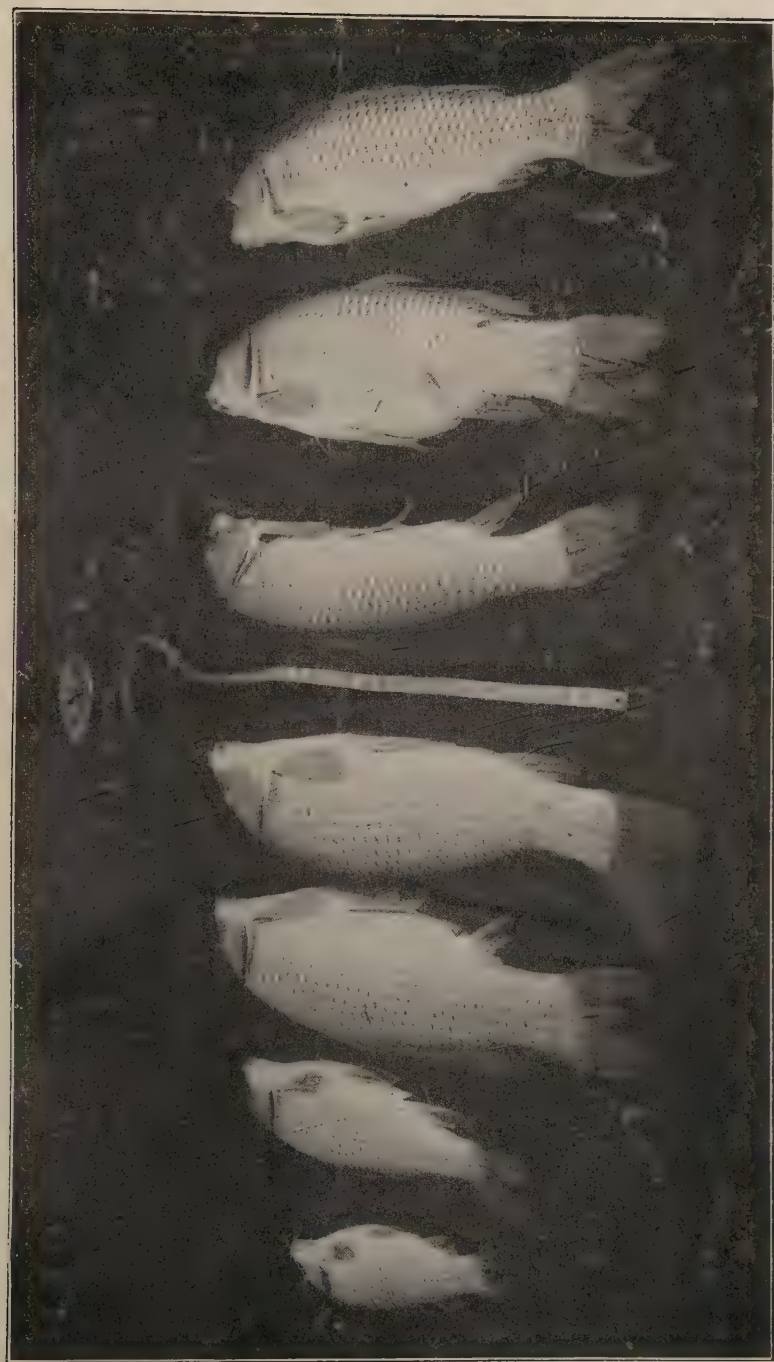
As already indicated, the most important family of fresh-water fishes in China proper is that of the *Cyprinidæ*, of which the characteristic member is the common carp itself. The family in its distribution and affinities is not an easy one to understand, and again we are forced to consult the palaeontologist if we should wish to do so. It seems that the *Cyprinidæ* were also of northern

origin, but did not originate so far north as the salmonoids, their range being more north temperate. Thence in Tertiary times they spread into more northerly latitudes, but like the salmonoids, suffered severely during the Glacial epoch. In Europe and Asia they found two refuge areas, namely, the Black and Caspian Seas area, and the Baikal area. The whole group was probably wiped out as regards the Amur and Manchurian region, though in China it still persisted. Thus in Post-glacial times they began to reconquer the northern parts of the great Eurasian land mass from several new and different "centres of dispersal."

Those that had found refuge in the region of the Black Sea and Caspian Sea spread into Europe and Siberia, meeting in the latter country those that had found refuge in the Baikal region, and even extending into the Amur region. But the Chinese cyprinids had been separated from those of Europe and Siberia since the beginning of the Glacial epoch, and so had differentiated along their own lines. These, too, began to spread north, meeting the others from Europe and Siberia in the Amur region, two forms, the common carp (*Cyprinus carpio*) and its near relative the Crucian carp (*Carassius carassius*), spreading right into Europe. These Chinese forms now predominate in the Manchurian and Amur regions, and, though in some ways resembling the European forms, are sufficiently different to warrant separation as under distinct genera. Thus the European bream, *Abramis*, is replaced by the genus *Parabramis*, the bitterling, *Rhodeus*, by *Acanthorhodeus*, and *Acheilognathus*, the gudgeon, *Gobio*, by *Leucogobio* and *Suarogobio*, and so on; while the true dace (*Leuciscus leuciscus*), the roach (*Rutilus rutilus*), the barbel (*Barbus barbus*), and the tench (*Tinca tinca*) are not represented at all in the waters of the Amur, Manchuria, or China. On the other hand these regions contain some totally new forms, such as *Ctenopharyngodon*, *Sarcocheilichthys*, *Culter*, *Hemiculter*, *Xenocypris*, *Opsariichthys*, *Zacco*, *Hypophthalmichthys*, *Squaliobarbus*, *Barilius*, and *Elopichthys*.

This is a formidable list of names and it is impossible to discuss here more than a few of the most interesting species that belong to some of these genera.

The common carp, the Crucian carp, and its near relative the golden carp (*Carassius auratus*), from which the well-known goldfish has been bred, and the Eastern chub (*Leuciscus brandti*),



A CATCH OF COMMON CARP MADE BY MR. L. W. C. LORDEN, OF THE CHINESE CUSTOMS SERVICE, IN SHANGHAI IN ONE MORNING

which occurs in Manchuria and North China at least, are all fish which readily take bait, and so must appeal to the angler. But they do not rise to a fly. Of these the common carp reaches an enormous size. It was introduced into England from the Continent, and it is said that wherever a Monk has been there the carp may be found. All four of the species just mentioned can live and thrive in stagnant ponds, and the Chinese breed them in many places for the table. It is almost certain that the common carp was introduced into European waters from China by human agency.

The culters may be recognized by their narrow bodies and usually upturned mouths. They reach a good size and weight. They are specially interesting to us since they will rise readily to a fly. They may be found in small streams and canals as well as in the larger rivers. The forms found in China and Manchuria are the bleak-like culter (*Culter alburnus*), the red-finned culter (*C. cryptropterus*), the sharp-headed culter (*C. oxycephalus*), the Mongolian culter (*C. mongolicus*), and the dace-like culter (*Hemiculter leucisculus*). The last is the little knife-fish, which offers such good sport to our Shanghai anglers. It has been described by Mr. L. W. C. Lorden in *The China Journal of Science and Arts* (May, 1924).

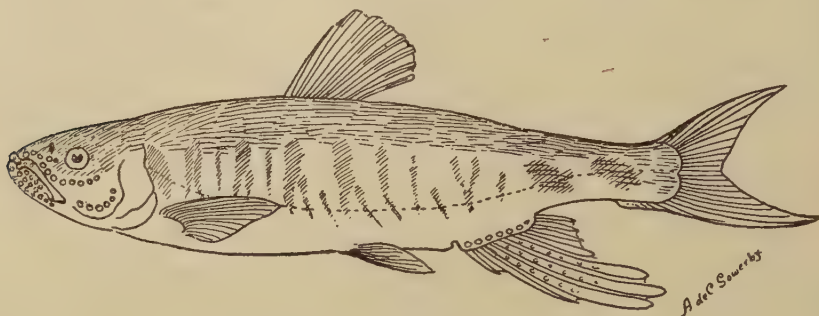
The two eastern breams, *Parabramis pekinensis* and *P. terminalis*, are beautiful fish much like the European species, but more slender and graceful, and of a more silvery appearance. They, too, will take a fly.

The peculiar fish known to science as *Hypophthalmichthys molitrix*, which inhabits the waters of Central and South China as well as those of Manchuria and the Amur basin, attains a large size. As its name suggests its eyes are situated on the under side of the head. Its mouth, on the other hand is turned upwards, much as in some of the culters, from which it may be argued that the fish is a surface feeder, and therefore liable to take a fly. As a matter of fact it does nothing of the kind. The under surface of this species is sharply keeled. Its scales are very small, while its colour is bluish or grey above, silvery below, with a tendency to red on the fins and in the eye.

Probably the most interesting of all the Chinese cyprinids are the members of the genera *Opsariichthys* and *Zacco*. Some authorities place the two together under the former of the two names.

These fish take a fly in exactly the same way as do the salmonoids, and offer exceedingly good sport. They are also very beautiful fish, especially in the breeding season. Several species of *Opsariichthys* are known, and these may be recognized by the peculiar notch that occurs in their jaws. On this account they may be known popularly as notch-jaws. They reach a fair size, and are to be found in clear rivers and streams. The place to catch them with the fly is where rapids occur. There are several species known, of which *O. uncirostris* inhabits Manchuria and Korea, and probably North China, *O. bidens* and *O. morrisoni* the waters of Central and Southern China. The genus is well represented in Japanese waters.

The same may be said of the genus *Zacco*, of which the little *Z. platypus* is one of the most beautiful of all the fish that occur in



THE RAINBOW CARP (*Opsariichthys bidens*)

those regions. During the breeding season it assumes a livery of brilliant blue, pale green, and the most delicate rose pink, its fins being marked in places with crimson. The green and pink occur on the sides, tongues of each colour running into the parts occupied by the other. The head is black, and is covered in the male during the breeding season with peculiar bony tubercles arranged in rows. While in Manchuria the writer saw various natives taking this fish with the same kind of fly as used for the trout, and himself caught several this way in one of the small affluents of the Yalu River. The species as well as *Opsariichthys bidens* of Central and South China which is similarly coloured, may be called the rainbow carp, owing to their bright breeding colours. Its range seems to extend from Central Manchuria in the north through Korea, the Japanese Islands, to Formosa.

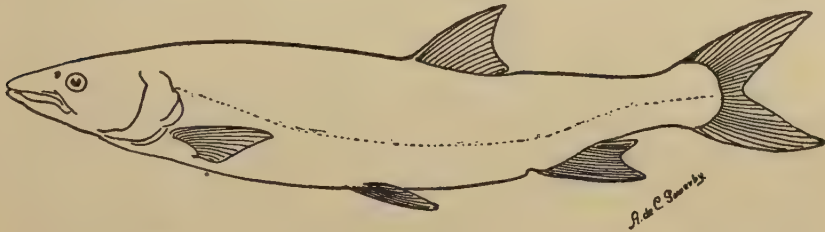


Photo by L.W.C. Lorden

THE COMMON CARP (*Cyprinus carpio*)

It is known from the waters of South-eastern China, where specimens were made the basis for describing a new species, *Z. acanthogenys*, by Dr. Boulenger of the British Museum. It is very doubtful, however, if those specimens really represent a distinct form. In any case the members of both the genera *Zacco* and *Opsariichthys* are to be found in waters within easy access of Shanghai, and those desirous of some good fly-fishing should go in search of them.

The largest of all the cyprinids in Chinese waters is the monster *Elopichthys bambusa*, which looks something like a salmon, but may easily be distinguished by the absence of any adipose fin, as the little fatty fin that occurs on the posterior part of the back of every salmonoid is called. It also has larger scales than is usual with the salmonoids. It is an inhabitant of large rivers from Canton to Mongolia and the Amur.



THE HUANG CHUAN (*Elopichthys bambusa*, Richardson)

Before passing on to other families of fish, it would be as well to refer to the small species that inhabit the lesser streams, such as are subject to partial or even complete dessication. In all the streams of the mountainous areas in the interior, a species of minnow (*Phoxinus lagowskii*) is to be found. It resembles the common minnow (*P. phoxinus*) of Europe, which with several other species is to be found in Manchuria and the Amur. Other small species that occur in mountain streams are some of the gudgeons and the little stone loach (*Nemachilus barbatulus toni*) and the still smaller spined loach (*Cobitis taenia*), which is almost the only cyprinid that occurs unchanged in both Europe and China. The much larger pond loach (*Misgurnus fossilus*) of Europe is replaced in Manchuria and China by a closely similar subspecies *M. f. anguillicaudatus*.

The next family to be considered is that containing the cat-

fishes. The *Siluridæ* are all characterized by the complete absence of scales and the presence of barbels on the jaws; while many of them have a well-developed adipose fin. They are mainly Chinese, Indian, African and American in distribution, and are supposed to have originated in the Indian Ocean area, whence in Quaternary or Recent times they spread north. The only European representative of the family is the wels or sheatfish (*Silurus glanis*), which is replaced in Eastern waters by members of the closely similar genus *Parasilurus*. The common form in China and Japan is *P. asotus*. It may at once be recognised by its broad head, long rather eel-like body, and wide mouth, whose jaws are adorned with long barbels. It and all the other catfishes to be mentioned here offer excellent ground-fishing. It differs from the following forms in that its lower or anal fin extends the whole length of the tail and joins up with the rounded caudal fin. It ranges from the Yangtze to the Amur, being replaced in Korea by a closely related form, another very similar species occurring in South-west China.

Other Chinese catfishes are *Pseudobagrus tenuis*, an elongate form that was described from the mouth of the Yangtze, *P. t. emarginatus*, a closely similar species, occurring in the Yalu River; *P. fulvidraco*, a shorter form, having a larger mouth and the body prettily variegated with dusky and yellowish; and *P. ussuriensis*, *P. brashnikowi*, and *P. herzensteini* from Manchuria and the Amur. All of these have the caudal fin separate from the anal fin. There are also several peculiar aberrant forms in South and South-west China and Korea.

The *Anguillidæ*, or eel family, is represented amongst the fresh-water fish of China by a species almost exactly like the European eel (*Anguilla anguilla*), but which has been separated under the name of *A. japonica*. It is a common species, specimens having been secured by the writer in the Tientsin, Chefoo and Shanghai areas and from the Yalu River. A variegated form called *A. bengalensis*, whose range is Southern Asia, has been reported from as far north as Shanghai, but this is doubtful and requires verification. In swamps and marshes in China a very peculiar type of eel known as *Monopterus javanensis* occurs. This remarkable fish, which attains a length of 2-ft. or more, looks much more like a serpent, being completely devoid of fins. It is of a yellow-brown colour, marked with blackish ver-

miculations. It belongs to a group that has been separated from the true eels under the distinct family name of *Symbranchidæ*.

In Manchuria occurs a single member of the *Esocidæ*, or pike family. This is slightly different from the European pike (*Esox lucius*) and has been given the distinct name of *E. reicherti*. It ranges up to the Amur, but is replaced throughout the rest of Siberia by the European form. It offers splendid sport to the angler.

The sticklebacks are represented in Chinese waters by a small, nine spined species called *Pygosteus sinensis*, two other forms, *P. pungitius* and *Gasterosteus aculeatus*, occurring in Manchuria and the Amur.

One of the commonest fishes in Chinese waters is the murrel or serpent-head (*Ophiocephalus argus*). It is known to the Chinese as *Hei Yu*, or black fish, and, though of coarse flavour, frequently finds its way to the table. It reaches a large size, and according to recent accounts offers fairly good sport to the angler.

A very common fish in rivers and streams from mid-China southward is the little paradise fish (*Polyacanthus opercularis*), which has been found useful as a mosquito destroyer. It is too small to appeal to the angler, but is an attractive aquarium species.

The nearest fish in China to the European perch are the so-called Chinese perches, a poor name, since they do not even belong to the perch family, but to that of the basses, *Serranidæ*. In fact, these fish may well be called fresh-water bass, offering as they do splendid sport with the rod and line. There are two forms, *Siniperca chuatsi* and *S. scherzeri*. Of those the former is abundant in most Chinese and Manchurian waters, ranging in the south to Canton and northward to the Amur. In general shape and colouring it resembles somewhat the European perch, being beautifully banded dark brown on an olivaceous background, spotted on the fins. The other species is less common. It was originally described from the mouth of the Yangtze, while the writer has secured it from the Yalu River. This form is marbled dark brown and yellowish. Both are excellent eating, and should be looked upon as a special prize by the angler fortunate enough to get one.

Finally we have the little bullhead or miller's thumb, a member of the *Cottidæ*, whose scientific name is *Cottus poecilopus*. This species has been recorded from China, but it is not common there, though plentiful enough in Manchuria. It ranges all the

way from Europe, through Siberia to these regions. In Manchuria and the Amur another species, *C. haitej*, occurs. Most of the members of this family are marine, but great interest attaches to the fact that several species, as well as members of two closely related families, occur in Lake Baikal. It appears that this deep inland sea has formed an area of differentiation for these forms, their ancestors having been left there from some long by-gone era when this part of Siberia was under the sea.

In Central and Southern China this type of fish is represented by two rather large bull-heads, known to science as *Eleotris sinensis*, Gunther and *E. oxycephala*, Schlegel.

This by no means exhausts the subject of Chinese fresh-water fishes. There are a great many other kinds in South China, with which it is impossible to deal here, while new species are being discovered and described all the time.

CHAPTER XIII.

SPINNING FOR THE HUANG-CHUAN.

In the previous chapter upon the fresh-water fish of China I have referred to the large fish known to the Chinese as *Huang-chuan*, and to science as *Elopichthys bambusa* (Richardson) as being a species that affords the anglers of Tientsin unusually fine sport. I now propose to give a more detailed account of this sporting fish, and how it is to be taken, in the hopes that some of the local anglers may be induced to give a little of their time to finding out if the same sport may be had in waters round Shanghai.

Elopichthys bambusa is easily the largest of the members of the carp family to be found in Chinese waters. In such rivers as the Yangtze and the Huang Ho it attains enormous proportions, specimens of well over one hundred catties (about 130 lbs. in weight being not uncommonly taken by fishermen in their nets. A visit to the fish market in such places as Tientsin or Shanghai will reveal to the curious specimens running up to sixty or eighty catties and measuring something like a yard and half in length. There is no mistaking this fish, for it looks uncommonly like a salmon, indeed, it is usually sold as salmon to Europeans' cooks, and certainly makes a good substitute for that finest of table fish.

But our species is not a salmon, or even a member of the salmon family, as is at once apparent when one examines it closely. It may be taken as an invariable rule that every member of the *Salmonidæ* has present on the posterior part of the back that peculiar little fin known as the "adipose fin." Any fish that has not got this must be something other than a trout or salmon or one of their numerous relations. The reverse does not follow, however, for there are certain groups of fish, as, for instance, the catfishes, in which a well developed adipose fin is often present. But there is no mistaking a catfish, since all the members of this family (*Siluridæ*) are free from scales and have their jaws adorned with barbels. The *Huang-chuan* has no adipose fin, though in general shape and appearance it is very like our British salmon. Its head

and jaws are extremely like those of the salmon, but on opening its mouth one finds that there are no teeth, or at least nothing conspicuous, such as characterize most of the members of the salmon family. In two other respects our species differs from the salmon, namely, in its much larger scales and less deep body, the latter being decidedly more slender than is usually the case with the royal fish. One strong point of resemblance between the *Huang-chuan* and the salmon lies in the fact that both can be "tailed." This is the angler's way of saying that the tail tapers to a certain point and then widens out again just before the caudal fin is reached, so that one may catch hold of the fish firmly at this point without fear of its slipping through one's hand. But this is a sportsman's distinction, and hardly a scientific one. In colour *Elopichthys bambusa* is silvery over most of its body, with a tendency to reddish on the fins, while its head is often of a brassy shade. It is a very handsome fish.

It is said that photographs of some of the specimens taken in the Tientsin district were sent home to be identified, and that the reply when it came was to the effect that the fish represented some form of pike, or at least a relation of that species. Far be it from me to contradict any of the home authorities, but it may be pointed out that it is not always easy to identify fish from photographs, while so far no member of the pike family has been discovered in China proper. A species of pike occurs in the rivers of Manchuria, but, so far as I have been able to determine, only in those that ultimately find their outlet into the sea to the east of Korea. Besides, the pikes have numerous and powerful teeth, a characteristic that no photograph would ordinarily reveal, while the dorsal and anal fins are set very far back in the body and opposite to each other.

This leaves only the great carp family, *Cyprinidæ*, to which our species can belong, and, indeed, when one comes to examine its characteristics, it soon becomes apparent that the *Huang-chuan* is a member of this family.

Some years ago, just when is not clear, a certain well-known resident in Tientsin is reported to have conceived the idea of introducing several kinds of fish into the creek that surrounds the Race Course in that Treaty Port. Amongst others were numerous small specimens of the *Huang-chuan*. Nothing more was thought of the matter till a few years back when Mr. R. P. Sanderson of the Tientsin Race Club, always an enterprising sportsman, ordered

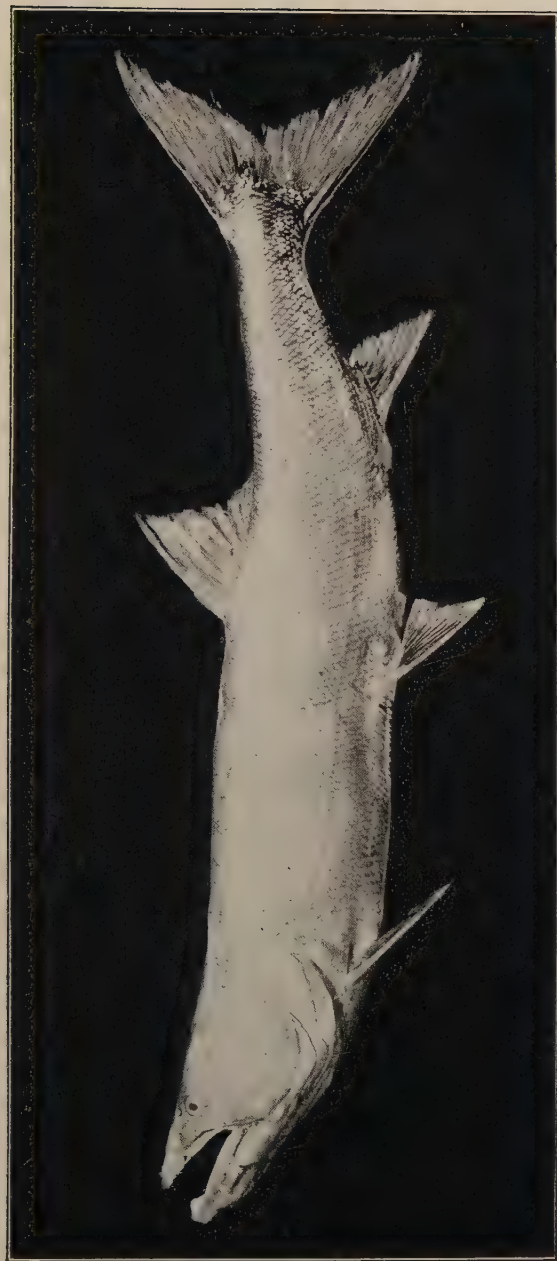


Photo by Percival Lea Birch

THE HUANG CHUAN (*Elopichthys bambusa*, Richardson)

out from home some fishing tackle for spinning, and tried his luck in the creek mentioned. I am not sure whether or not he met with immediate success, but the end of the matter was that he got some fine specimens of *Huang-chuan*, thus becoming the pioneer of a sport that is certainly going to become increasingly popular in the district. It was found that the best bait to use was a live fish of about eight or ten inches in length attached to a spinning head with several hooks. This should be thrown well clear of the bank and the line reeled in at a good but even rate. If the fish are about and biting they come with a terrific rush, and before the angler knows quite what has happened his line is being taken out at an alarming rate. His hands will be full for the next twenty minutes or half hour, and only if he is very skilful will he succeed in landing his prize, for the *Huang-chuan* rivals the salmon in its qualities of gameness, and puts up a big fight for its life.* Great care has to be taken not to let the fish get into the weeds that are always abundant in such places, but once it has been played to a finish and successfully gaffed and landed, the angler may well pat himself on the back, for there is no finer piscine quarry than *Elopichthys bambusa* to be had in Chinese waters.

Up to the present the record specimen taken this way for Tientsin was a fish caught by Mr. F. J. L. Shaw weighing 25 lbs. Other specimens of 18 lbs. and 17 lbs. have been taken by Mr. Sanderson, while 8 lb. specimens are common. Of course there are the usual accounts of exciting encounters with much larger fish, and we must suppose that these records will some day be broken. On one occasion an angler had an eight pound fish on his line when a monster came up and actually tried to sieze it. Several times fish have been hooked that defied all efforts to land them, leaping clear of the water and showing the tantalized angler sufficient to drive him almost mad when the line ultimately parted and the quarry made its escape.

It is rather a remarkable thing that our species should be such a voracious feeder when it has no teeth such as are possessed by the salmon and pike.

The range of the *Huang-chuan* extends from Northern Mongolia, where it occurs in the rivers that flow into the Amur and the

* I have had this contradicted by certain anglers who have taken *Huang-chuan*, but would suggest that the size of the hooks and thickness of line used have something to do with it.

Liao, throughout Manchuria, North China, the Yangtze Valley, and on down to the rivers of Canton Province. There is not the slightest reason, as far as one can see, why this fine fish should not be taken by Shanghai sportsmen in the immediate vicinity of this Port. It only remains for some one to discover just where good sized specimens are to be found, and to that end one would like to suggest that the local anglers should send to England or America for the necessary tackle and try their luck in some of the numerous creeks in this vicinity.

CHAPTER XIV.

THE CHINESE STURGEON.

Scattered throughout the waters of palæarctic regions in the Northern Hemisphere are a number of species of large fish that go collectively by the name of sturgeon. They belong to the order *Chondrostei* of the sub-class *Osteichthyes*. That is to say, they are fishes with bony skeletons and, amongst other distinctive anatomical characteristics, have heterocercal tails, as in all primitive fishes, numerous bony plates in the skin of the head, and weak jaws with very small or no teeth.

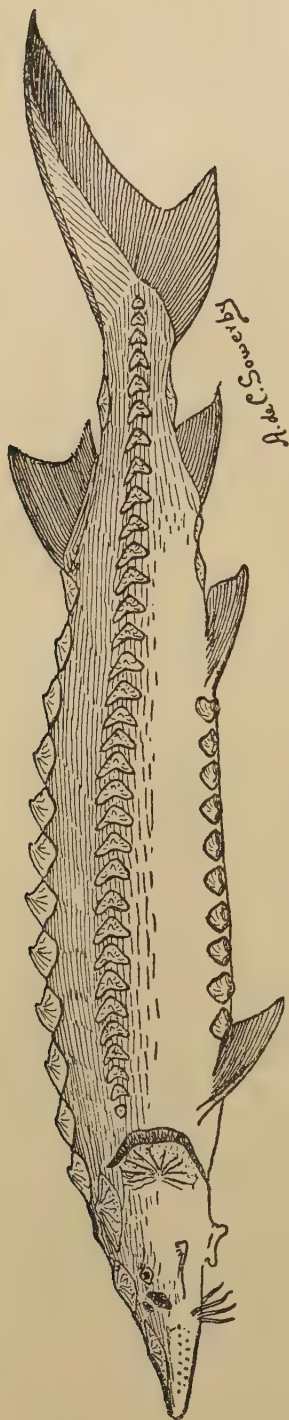
The order contains two families with a comparatively limited number of genera. These are :

(1) *Acipenseridæ*, in which the skin is covered with bony scutes or shields in five longitudinal rows, and to which belong the genera *Huso*, *Acipenser*, *Pseudoscaphirhynchus*, and *Scaphirhynchus*.

(2) *Polyodontidæ*, in which the skin is either naked or has only deeply buried vestigial scales, the snout is prolonged into a distinct rostrum, and minute teeth are present in the mouth. To this family belong the two genera *Polydon* and *Psephurus*.

The genera *Huso* and *Acipenser*, to which the term "true sturgeon" may apply, are represented, the former by two species, *Huso huso* of the Black Sea, Caspian Sea, and their affluents, and *H. dauricus* of the Amur River basin, the latter by some ten or eleven species which range from Western Europe to Eastern Siberia, Northern Japan and China and occur in the rivers of North America on either side of the great Rocky Mountain divide and its continuations. The best known form of *Acipenser* is the common sturgeon (*A. sturio*), which inhabits the rivers of Europe from the Volga and Danube westward, also occurring in the rivers of the eastern states in North America as far south as Florida.

Another well known form is the sterlet (*A. ruthenus*) which ranges from the eastern part of European Russia right across Northern Siberia (not in Lake Baikal) to north of the Amur Basin.

THE CHINESE STURGEON (*Acipenser sinensis*)THE YANGTZE BEAKED STURGEON (*Psephurus gladius*)

In the Amur Basin we have Von Schrenck's sturgeon (*A. schrenckii*), which in turn is replaced in Chinese waters by the Chinese sturgeon (*A. sinensis*).

Another species, *A. baeri*, occurs in Siberia including Lake Baikal; while *A. brevirostris* occurs with *A. sturio* in the Eastern United States; *A. rubicundus* in the regions of Canada and the United States, north of the Great Lakes; and *A. transmontanus* and *A. medirostris* west of the Rockies.

Two species of sturgeon have been described from Japan, namely, *A. kikuchii*, Jordan & Snyder, and *A. mikadoi*, Hilgendorf. The latter is the common sturgeon of North Japan, the former being a rare form, with a longer dorsal fin, fewer dorsal plates and a shorter snout.

The two species of *Huso* were formerly classed with the genus *Acipenser*, but they are now considered generically different. They may be known popularly as giant sturgeons.

The members of the genera *Scaphirhynchus* and *Pseudoscaphirhynchus* may be distinguished from the true sturgeons by the fact that they have the snout prolonged into a spatulate beak, hence being known popularly as the shovel-nosed sturgeons. *Scaphirhynchus platyrhynchus*, the sole representative of its genus is North American in distribution, while the three species of *Pseudoscaphirhynchus* inhabit the rivers of Central Asia (Turkestan), never descending to the sea.

The two members of the family *Polyodontidae*, or spoon-beaked sturgeons, as they are popularly called, are *Poloydon folius* of the Mississippi and *Psephurus gladius* of the Yang-tze Kiang and Huang Ho. The latter is said to reach a very large size, and neither should be confused with the shovel-nosed sturgeons, in which there are bony scutes as in the true sturgeons.

The Chinese sturgeon, though comparatively common, is not at all well known. First described by Grey from the Canton region, there are but few scientific records of its occurrence, due, doubtless, to the large size of the fish and the consequent difficulty of preserving and sending it to museums in Europe and America.

From time to time large specimens are taken and cause comment in the local newspapers and interest amongst foreigners and natives alike. Thus a nine foot specimen was exhibited on the streets of Tsi-nan Fu in Shantung not long ago, and was acquired by the Tsi-nan Fu Institute, where it was mounted and placed on

exhibition. Some few years ago (June 8, 1911 to be precise) an even larger specimen was caught in the Dragon River (Loong Tan Hok) Fukien, and offered for sale in Foochow, where it was photographed, subsequently being purchased by a wealthy merchant and set free in the Min River at Lim Po the following day. It is remarkable that this fish should have lived so long out of water. This specimen measured 11 feet, $5\frac{1}{2}$ inches, and weighed 438-lbs.

The writer purchased a small specimen in the Hongkew fish market, Shanghai, in the month of May, 1924, and has since seen a number of others on sale there, but has been unable to gather any information as to the habits of this species, or where or how these specimens were taken beyond the fact that they were caught in the Yang-tze.

In classifying sturgeons special note is taken of the number of rays in the fins, and the number of scutes in the various (five) rows that run longitudinally down the body. One row, the dorsal, extends along the median line of the back, one, the lateral, down the middle of each side of the body and tail, and one, the ventral, down each side of the ventral surface. These scutes are bony and more or less flatly conical in shape with rhomboidal bases. In the Foochow specimen there were 18 dorsal and 45 lateral scutes. In the Tsi-nan Fu specimen, which had evidently been taken in the Yellow River, there were 14 dorsal, 36 lateral and 12 ventral scutes, while the dorsal fin contained 41 rays, the pectoral fins 24, the ventral fins 28, the anal 20, and the caudal 28. Expressed according to formula this runs :

D 41, A 20, P 24, V 28, C 28 ; Sc. dors. 14, later. 36, vent. 12.

It may be mentioned that the Chinese sturgeon differs from Von Schrenck's sturgeon of the Amur, its nearest neighbour, in having smaller pectoral fins, and a greater number of ventral scutes, the largest dorsal scute being the first and not the middle one in the row, while there are fewer small scales between the rows of large scutes.

With its pointed, triangular snout, somewhat depressed head, small eyes, gaping gill-clefts, peculiar, protractile mouth situated on the under surface of the head, long, somewhat slender and tapering body, rows of pointed, bony scutes forming a regular armature, and heterocercal tail, the sturgeon is a most remarkable

looking fish. There are four barbels on the lower surface of the snout. The colour, in life, is of a fine slate grey, white on the under surface. Sturgeons are said to feed on the bottoms of the rivers and bays they inhabit, and presumably use their long snouts for stirring up the mud and sand to dislodge their prey, fishes and the like, that lurk there.

The true sturgeons are partially marine, partially freshwater inhabiting. They ascend the rivers to breed, some returning to the sea after this operation, others not. They are said to winter in shallow bays of the sea coast or in deep pools in large rivers, partially burying themselves in the mud. In northerly regions, especially in Siberia, they appear in the rivers in great swarms when the breeding season (early summer) comes on.

In China members of the local species make their appearance from April to June; but nothing is known of their habits. The Chinese name is *Huang Yü*, which means Emperor Fish, and it is said that, as in England, all sturgeons have to be sent to the reigning monarch. Hence the species might well be called the Chinese Royal Sturgeon.

The roe of the sturgeon is the highly esteemed delicacy known as black "caviare," while from the inner coating of the air-bladder isinglass is made. The flesh of the sturgeon is considered excellent, and in Siberia it is salted and smoked in the same way as that of the salmon. It is very rich in fat or oil.

CHAPTER XV.

THE YANGTZE BEAKED STURGEON.

Probably the most remarkable of all the many remarkable fishes of China is the beaked sturgeon of the Yangtze, scientifically known as *Psephurus gladius*. Belonging to that group of bony fishes called *Chondrostei*, which includes the sturgeons generally, it and its near relation, the spoon-beaked sturgeon (*Polyodon folius*) of the Mississippi, have been placed in a separate family to which the name *Polyodontidæ* has been given on account of the presence of teeth in these two species. They are the only two living members of the sturgeon tribe in which teeth are present. All the other sturgeons are placed in the family *Acipenseridæ*.

One of the earliest records of this peculiar fish is to be found in Blakiston's "Five Months on the Yangtze," published in 1862. On pages 76 and 77 the following passage occurs:—

"When we anchored, numbers of boats came off from the shore offering fish for sale at a low price, some of which we found very good eating. We only bought one, however, out of curiosity, as being of a very singular appearance. Dr. Barton's sketch will explain it better than I can in writing. It was three feet in length, with a large bell-shaped projecting mouth, and a snout or horn sticking out over twelve inches beyond the head. From these particulars naturalists may perhaps be able to recognize the species; it had somewhat the appearance of a dog-fish or shark."

The sketches by Dr. Barton, which are also given, leave no room for doubt as to what fish is described. The present writer has recently secured a number of specimens of this peculiar fish from the Hongkew Market in Shanghai, and the following description is based on these.

With the body-form roughly that of a shark, the beaked sturgeon is chiefly remarkable for the long, depressed beak into which the head is drawn out. This beak is thick and wide at the base, growing flatter and flatter towards the apex which is pointed. At about half-way along its length it widens slightly and then

steadily narrows to the tip. It is thus roughly the shape of a broad sword blade. The bones of the skull are produced anteriorly to form a support for the beak which is otherwise fleshy or cartilaginous. The bone extends to the tip, forming a sort of mid-rib. The distance from the tip of the beak to the back of the head is almost half that of the total length of the fish. The whole of the beak and extensive areas of the head and gills are studded with groups of little pits. The eyes are small and set at the sides at the base of the beak. Just in front of, and a little above, them are the nostrils. On the under side of the beak, one on either side and close to the mid-rib, and at a distance of about a quarter of the distance between the mouth and tip of the beak, two tiny barbels occur.

The mouth is inferior and is very large, curved like a bow when closed, and armed with numerous small teeth on both jaws. There are also teeth on the tongue. The gills are very pronounced, each gill-covering extending backwards on the side of the body in the form of a fleshy sheath ending in a point. There are no scales or plates of any kind on the body, down the sides of which a pronounced lateral line extends. The skin is smooth. The fins are like those of the true sturgeon, being many-rayed. The rays are so close together and slender that it is difficult to count them, but as near as may be made out the fin formula is as follows :

D 58, A 55, P 35, V 36, C 114.

The pectoral fins are not very long, and are truncate. The pelvic fins are small. The caudal is homocercal, the lower lobe much shorter than the upper. The head is large, wide and depressed, wider than deep, longer than wide. The body is cylindrical anteriorly, compressed laterally. The colour is greyish-brown above, whitish below, the base of the caudal fin being yellowish, and the tips of the rays dusky. The beak is semi-translucent with practically no colouring. The eye is black. The size to which the fish grows is not definitely known, but specimens of three and four feet have been recorded. It is said that it attains a length of 20-ft.

Of the habits of the beaked sturgeon little is known. It is an inhabitant of the muddy waters of the Lower Yangtze, and from the position of the mouth it must be assumed that it feeds upon the bottom. It is probable that it uses its long sword-like

but rather soft, beak to dig in the soft mud for its food. The minute size of the eyes shows that it can depend but little upon these organs to assist it in capturing its prey. The nostrils are of useful size and enter fairly large cavities in the head. The only thing found in the stomach of specimens examined by the writer were the remains of small fresh-water prawns, the species of which were unidentifiable. The size of the mouth and the presence of teeth suggest larger prey than this, probably fish of some sort and possibly water-snails and mussels. Nothing is known about its breeding habits, where it spawns, or what its eggs are like.

The remarkable distribution of the beaked sturgeon and its close relation the spoon-beaked sturgeon of the Mississippi, which differs only in having the beak much broader and spoon- or shovel-shaped instead of sword-shaped, is worthy of comment. The one species is found only in the Yangtze and its tributaries, the other only in the Mississippi. A similar singular distribution also occurs in the cases of the alligators and giant salamanders. Of the only known true alligators of the world one occurs in the Yangtze and another in the Mississippi and neighbouring regions. The habitat of the third, *Alligator helios*, is not known. Of the giant salamanders, one genus, *Megalobatrachus*, is represented in the mountain streams of Central and South China and Japan by two species, *M. sligoi* (South China) and *M. japonicus* (Japan). There is some doubt concerning the identity of the Central China form. The other genus of giant salamanders is *Cryptobranchus* represented by a single species, *C. lateralis* or *alleghaniensis*, and is found in the Mississippi ranging into North Carolina.

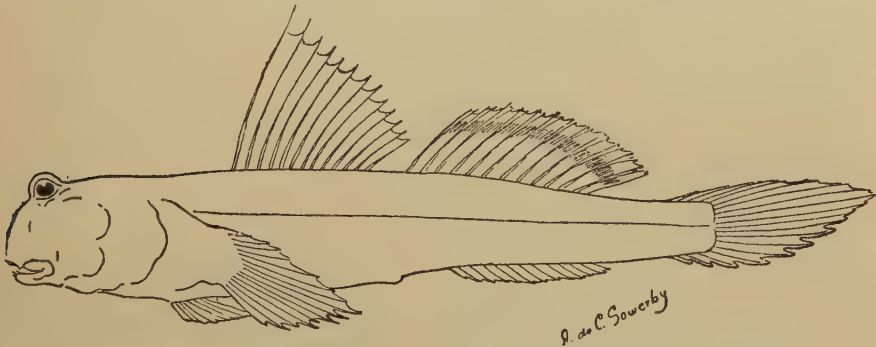
The explanation of the distribution of these three distinct groups of animals has not been found, but it at least shows that at some period of the Earth's history China and the area now forming the Mississippi Basin were in some way connected. It is significant that all three groups belong to very ancient types of animals.

The beaked sturgeon is sold in the Chinese fish markets and is considered to be very good eating.

CHAPTER XVI.

THE MUD SKIPPER.

The other day while crossing one of the numerous tidal creeks that intersect the country round Shanghai I noticed a small fish dive from the muddy bank into the water. My taxidermist was with me and I pointed out the spot where the fish had disappeared amongst some debris at the bottom of the water, and was more than gratified when the lad, after scanning the spot for a few moments, made a sudden dive with his hands and brought out the little creature wriggling and struggling.



THE CHINESE MUD-SKIPPER (*Periophthalmus cantonensis*, Osbeck)

He laid it on the footpath where instead of flopping about in the usual helpless way of fishes it began skipping over the ground at a considerable speed, keeping its body in the correct position instead of on its side. A careful examination showed that progression was made in two ways. The rapid skipping was accomplished by the fish curling its tail round to one side and then straightening it out with a jerk; while crawling was carried out by a vigorous use of its pectoral and pelvic fins, the former being situated on the side of the body near the head, the latter below and a little to the back of them on the ventral surface.

The little fish was a specimen of the so-called mud skipper, of which the Chinese species is known to science as *Periophthalmus cantonensis* (Osbeck)*, having been first described from Canton. The mud skippers belong to the family *Gobiidae*, being related to the gobies, and have a distribution in more or less tropical regions along the coasts that fringe the Indo-Pacific Ocean and on the west coast of Africa. They are extremely abundant on all mud-flats and tidal estuaries and creeks, where they spend the greater part of their time out of the water creeping about and skipping over the muddy surface, and even climbing the lower stems and exposed roots of mangrove trees, grasses, bushes and other plants that occur near the water's edge. In many cases these fish are to be found in almost dry ditches and creeks well away from the main streams or estuaries, and here they have holes in the mud at the bottom of which is water, and into which they retire when danger threatens. Some of the more tropical species reach a good size, that is to say, six or eight inches; but the Chinese species is considerably smaller, at least in the more northerly limits of its range. All the species are, however, very closely similar, so that a description of our specimen will serve to introduce the reader to the whole group.

The total length of our specimen, including the caudal fin, is three and a half inches, the length of the head going 4.6 times into this total length. The depth of the body is one seventh of the total length. The body is somewhat elongate and tapering, slightly compressed laterally. It is covered with small cycloid scales, about 75 along the length of the body. The eyes are situated high up on the head and can be protruded or withdrawn after the manner of the eyes of a frog or toad, at the same time being furnished with an outer eyelid. The dorsal fins are high, the anterior or spinous one being completely divided from the posterior or soft-rayed one, and each having twelve rays. In the anterior dorsal fin the rays extend beyond the web. The caudal fin is wedge-shaped, with the lower rays short and stiff. The anal fin is low and contains twelve rays. The pectoral fins are remarkable in that they are muscular and jointed, having a distinct elbow,

*Since writing the above I have secured specimens of two other species in the Hongkew fish-market. One of these is about the same size as *P. cantonensis*, but has lower dorsal fins, and is less slender: the other is a much larger form, with a short very high anterior dorsal fin, in which the few (five) rays extend well beyond the web, fins and body being beautifully spotted with pale blue.

the fish being able to utilize them as walking limbs. The pelvic or ventral fins are situated far forward, directly under the pectoral fins, are joined to form a sort of shallow cup—not so distinct a cup as in most other gobies—, and are also used by the fish to help in its progress on land. The jaws are fringed with small sharp-pointed teeth. The colour of our specimen in life was of a light buff-brown with beautiful pale iridescent blue spots along the sides. The posterior dorsal fin was beautifully banded with white, black and light chesnut buff. The caudal fin was blackish in the middle, buff round the edges. These colours disappeared soon after the specimen was preserved in formalin.

The whole form of the fish shows adaptation to a partially terrestrial environment. The openings of the gills are greatly reduced, and the gills themselves small. The food of the mud-skippers consists of insects which they catch on land, displaying considerable agility. When caught our specimen extended its fins to their full extent, and snapped viciously.

While passing through the Straits Settlements some years ago I had ample opportunity of watching the mud-skippers that thronged the muddy banks of the rivers and creeks, and they afforded endless interest with their alert attitude and lively ways. When alarmed they usually made for the water along the surface of which they skipped in the most extraordinary manner. It was almost uncanny the way the fish raised themselves on their fins at one's approach, apparently to obtain a better view of the intruder: then off they would go like frightened sheep skipping along the muddy flats on to the water. If they dived into the water it was soon to reappear further along the bank and crawl out again on to land.

We have in the mud-skipper a very interesting example of a group of animals actually in the process of evolving from an aquatic to a terrestrial life. It sounds absurd to say that a fish can drown in water, and yet, so far have these fishes progressed in their evolution from water to land animals, that they are actually air-breathers, and rapidly drown if placed in water from which they cannot escape on to some exposed surface. The pectoral and pelvic fins have assumed the function of walking limbs to a considerable extent, and one must suppose that it is only a matter of time for these fish to forsake the water altogether and become land animals. If rock-history is to be believed, it

must have been in a very similar way that the ancestors of the present day land animals left the water, their original home. It is interesting to speculate on the future of the mud-skipper. What possibilities do not lie before them! Already their intelligence appears to have advanced considerably on that of other fishes, to judge by their actions and alert bearing, and one cannot but feel that here, in embryo, is a possible race of future inhabitants of the earth, that may even replace, in time, the higher vertebrates, including man, that now dominate terrestrial areas.

CHAPTER XVII.

THE PARADISE FISH AS A DESTROYER OF MOSQUITO LARVAE.

During the spring and early summer of the past year the writer has been experimenting with various species of small fish commonly found in the ponds and streams round Shanghai, with a view to discovering which, if any, may be used with advantage in the campaign against mosquitoes.

In Central and South America the destruction of mosquito larvae has been carried out very successfully by introducing certain species of small fish native to that country into all standing water. For instance, it was found that, during a severe outbreak of yellow fever in Peru, the introduction of these small fish into the tanks, ponds, and other standing water, in the proportion of two fish to every gallon, checked the outbreak and it was finally completely got under control within a period of some thirty days. As every one knows, yellow fever is carried from person to person by the banded mosquito (*Stegomyia fasciata*) and it was the small fish destroying the larvae of this insect that finally stopped the epidemic.

This being the case it was realized that if a suitable fish could be found in China—a small species, widely prevalent, easily procurable, and a devourer of mosquito larvae—a very effective and valuable weapon would be placed in the hands of medical boards in their war against malaria, and in the hands of municipal authorities in their attempt to exterminate one of the worst nuisances in the country.

The Chinese species upon which observations have been made are the gudgeon, the bull-head, the bitterling, the crucian carp, the catfish, the mandarin fish, young Chinese chub, young culters of various species, the common eel, young serpent-heads, loach of various species, the Chinese paradise fish, and the young of other species, whose names need not concern us here. These were kept in spacious glass jars or aquaria, the contents of which were made as closely similar as possible to the natural surroundings of the fish.

It was found that none of these species, excepting the crucian carp, serpent-heads, loaches, and paradise fish, survived very long in the aquaria, unless the water was changed almost daily. Some died within a few hours of being placed in the jars. This means that they would not be likely to survive in small ponds or in stagnant water. As a matter of fact they are all inhabitants of large ponds or running water, and so are useless for the purpose in question. In order to combat the mosquito pest it is necessary to have a small fish that will live in the most stagnant and foul water. These inhabitants of running water being eliminated, it remained to examine the species that can survive in small, still bodies of water, such as breed mosquitoes.

Of these it was found that the crucian, or golden, carp (*Carassius auratus*) is a comparatively sluggish species, besides having the drawback of growing rapidly into a rather large fish. Also the Chinese are very fond of it as food, and it would be difficult to keep them from netting the ponds in which this species was present in any numbers. It may therefore be ruled out as unsuitable.

The serpent-head (*Ophiocephalus argus*) on the other hand, is unsuitable because of its voracity. When small it is a very greedy devourer of mosquito larvae, but it, too, grows rapidly, and is obsessed with cannibalistic tendencies. One specimen measuring some six inches in length, which was kept in a jar with a loach of almost its own size, swallowed its companion. The thing that would happen if this species were used would be that as the specimens grew up the larger ones would devour the smaller ones, and there would be no keeping up a permanent supply.

The various species of loach, such as the pond loach (*Nemacheilus barbatulus toni*), the common loach (*Cobitis taenia*), or the giant loach (*Misgurnus anguillicaudatus*), all devour mosquito larvae with avidity, but they are frequenters of marshes, paddies, and muddy bottoms; and seldom if ever come to the surface, where the wrigglers congregate. Also they do not thrive in deep water, while the Chinese value them as food, and catch them whenever they can.

Thus, by a process of elimination, we come down to the little paradise fish, or rather, the wild species from which the paradise fish has been cultivated. Its scientific name is *Polyacanthus opercularis*.

After keeping a number of specimens for several months, feeding them on all sorts of things, often leaving them in the same water for weeks till it was green and stagnant without harming them in any way, and finally noting the avidity with which they consume any mosquito larvae placed in their tanks, I do not hesitate to say that everything points to this species, more than any other of the fish available in these parts, being the one with which to combat the mosquito pest.*

It is a small species, never exceeding three or four inches in length. It will live in any water, no matter how stagnant. It is extremely voracious, and will eat large numbers of wrigglers in a day. And it is *not* a food fish, which means that a pond containing only this species will be left alone by the Chinese. This last is a very important point. There remain only breeding experiments to be carried out, which, of course, cannot be done in small aquaria, but must be done on a large scale.

One might suggest that the Municipal Health Department acquire some suitable ponds and experiment on an extensive scale in order to see whether or not these little fish can be raised in sufficiently large numbers to supply all the ponds, tanks, artificial waters, and stagnant pools in the vicinity of Shanghai, and so do what has been done with such marked success in America.

The paradise fish is said to make a nest of mud and weeds in which the female lays her eggs, and which is subsequently guarded by the male. This means that special arrangements for breeding will have to be made, unless experiments show some easy way of handling the matter, as, for instance, in the case of salmon and trout hatcheries in the home lands.

Polyacanthus opercularis is a beautiful little fish, the body being of a general brownish colour. The long, high fins have the margins of a rich reddish colour, and are spotted with pale, bright, iridescent blue. There is a dark greenish-black spot on the gill-plate. When excited the little fish spreads its fins to their full extent, their colour becoming intensified, while dark, almost black bands appear on the sides of the body.

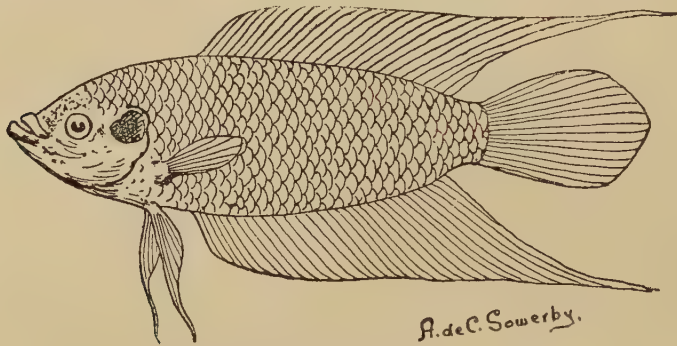
The species is extremely pugnacious, the males indulging in frequent fights, in which the winner or more aggressive chases the

* Since this was written it has been found that the little "top-minnow", an American species, has been introduced into certain artificial ponds in Shanghai and have become acclimatized, breeding freely. This is undoubtedly a better species to use than the paradise fish, since it is smaller and breeds more rapidly.

vanquished all over the place. The males also love to display themselves in front of the females, raising their dorsal and anal fins to their full extent, spreading the tail-fin like a fan, and violently agitating the pectoral fins, while the ventral fins, long and tapering, and set well forward, hang motionless, or wave gently in the water.

These fish are extremely attractive, especially in aquaria. They easily surpass the well known gold-fish, since, not only are they beautifully coloured, but they are much more sprightly and interesting in their habits. They become very tame, and even allow themselves to be stroked gently with the finger. They will come to the surface to be fed, and will eat almost anything.

So attractive is this species that in South China it has been specially bred and from it has been evolved the cultivated paradise



THE PARADISE FISH (*Polyacanthus opercularis*)

fish, which at one time was thought to be a distinct species, to which was given the scientific name *Macropodus viridi-auratus*. In this the fins are even longer than in the wild form, while the tail-fin instead of being rounded is forked, with two long streamers. The two forms are one and the same, so that the name paradise fish may be used for both.

The species is distributed all over this part of China, in ponds, streams, creeks, and rivers, and I have preserved specimens from a number of places in Kiangsu and Fukien provinces. There should be no difficulty in securing large quantities for experimental purposes.

CHAPTER XVIII.

THE MANDARIN FISH.

In the March, 1924, issue of *The China Journal of Science and Arts* appeared an article by Mr. L. W. Lorden on "Fishing in China" in which he dealt with the delightful little fish called the knife fish. He suggested that those who have had experience with fish and fishing in this country should contribute further articles from time to time, in order to rouse interest in the sport and increase general knowledge in China regarding the fish-fauna of her rivers, streams and lakes.

Agreeing with this laudable object I have decided to write upon one of the most valuable and highly prized fresh-water fishes of China, and to show how it may become famous, not only for its gastronomic qualities, as it now is, but also as a sporting fish worthy of the attention of the European or American angler in this country.

The Mandarin fish is a member of the great bass family, *Serranidae*, and is not a perch (family *Percidae*) as supposed by so many. Its generic name *Siniperca*, meaning Chinese perch, and created by Gill in 1862, is, therefore, misleading. The species was originally described in 1855 under the name *Perca chua-tsi* on specimens from Peking by Basilewsky, who wrongly supposed it to be a perch. Basilewsky adopted the Chinese name, *Chua-tze*, as its specific name, a procedure not uncommon amongst naturalists when describing new species. Its correct scientific name, therefore, is *Siniperca chua-tsi* (Basilewsky).

In appearance, it must be admitted, the Mandarin fish is not unlike a perch, but a closer examination reveals many points of difference. The body is deeper, the back higher, sloping more sharply from the head to the dorsal fin. The lower jaw protrudes in an aggressive manner, the mouth being very large and armed with sharp strong teeth. The scales are small, so small that at a short distance the fish has the smooth appearance of a scaleless form. In colour our species is of a rich olive-yellow-green, fading

to pale yellowish white on the under parts. A dark band of rich brown or brown-black passes through the eye from the snout up the side of the head to the back; while broad, sometimes broken bands or irregular patches of the same colour extend transversely across the body on either side. The dorsal and caudal fins are spotted with round dots of the same colour.

The fin and scale formula given by Dr. L. Berg in his book "*Ichthyologia Amurensis*" is as follows :

28—30

D XII 13—14, A III 9—10, l.l. 108—120, Squ. 150—

75—85

In plain English this means that the dorsal fin has twelve spiny rays and from thirteen to fifteen soft rays, the anal fin three spiny and from nine to ten soft rays : there are 108 to 120 pores along the lateral line, 150 scales in a lateral line from head to tail fin, and twenty-eight to thirty in a perpendicular row above and seventy-five to eighty-five below the lateral line.

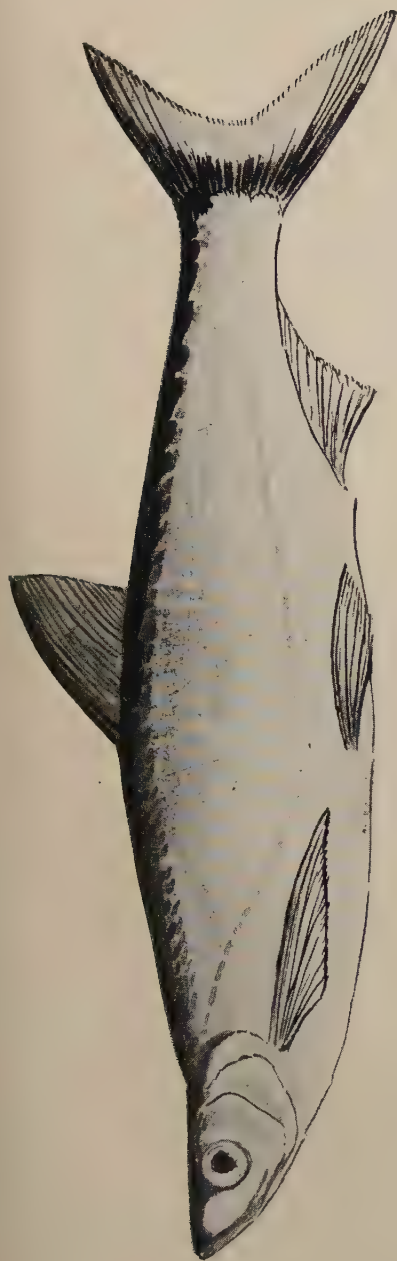
The three spiny rays of the anal fin are very strong and sharp and are characteristic of the basses.

There are spines on the gill-plates, also characteristic of the basses. With these, the anal spines and the spiny rays of the dorsal fin the Mandarin fish is well armed, and should be handled very carefully, especially as the spines are to a certain extent poisonous, and wounds inflicted by them are very painful.

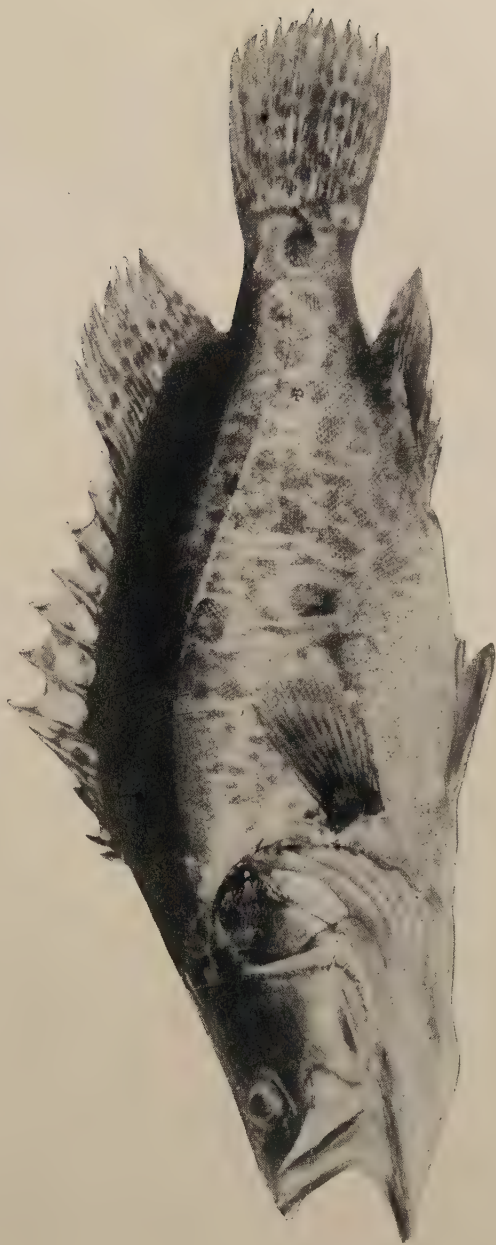
The species reaches a large size, specimens of 10 or 12-lbs. being not uncommon.

So much for the general description of our fish. That it is suitable as a fish for angling admits of little discussion, though whether it is a sporting fish in the fullest sense of the word remains to be proved. The points in its favour are that it is universally distributed all over East China from the extreme south northward as far as the Amur River in Manchuria and throughout Central China, where it is to be found in all the rivers, creeks, lakes and even marshes. It breeds in the creeks, smaller streams, lakes and marshes, where it deposits its spawn amongst the thick weeds. Spawning takes place in the spring.

The second point in its favour is that it is a voracious fish, feeding upon other fish, shrimps and prawns, and may be taken with a live bait consisting of a small fish or large prawn. As far as I know no attempt has been made to take it with a spinner or



THE KNIFE-FISH (*Hemiculter leuciscus*)
From a drawing by L. W. C. Lorden



THE MANDARIN FISH (*Siniperca chuatsi*, Basilevsky)

with the fly, though great success has been met with in this direction with its near relative, the Japanese sea-bass (*Lateolabrax japonica*). Here, then, is a line of investigation for the local brotherhood of the rod and line.

The only doubtful thing about the Mandarin fish as a sporting species is whether it is not too sluggish, my observations tending to show that it is not nearly as active a fighter as its American cousin, the black bass.

A very closely related species is also found in the rivers, creeks and lakes of China, namely a species that enjoys the scientific name of *Siniperca scherzeri*. It is usually confused with the Mandarin fish, which it resembles in general appearance, but from which it differs in being of a richer, more bronzy colour, in having irregular, more closely set and more definite blotches and patches instead of bars on the sides, and in being less deep in the body.

I enjoyed excellent sport with this fish while on the Yalu River, Manchuria, early one summer. The bait used consisted of fresh earth worms, and the fish fought well. The species was described from the Yangtze.

The Japanese sea-bass also ascends rivers in China, and may be found in all the creeks that intersect the province of Kiangsu. It is of a beautiful silvery colour spotted with black, and is longer and less deep in the body than either of the foregoing.

Recently, splendid sport has been had at Pei-tai Ho and other seaside resorts in North China, taking this fish with the fly; and I am convinced that there are great possibilities along the same line with the other two species mentioned here.

CHAPTER XIX.

ANIMAL LIFE OF THE CHINA COAST LINE.

Most people who visit the seaside for their summer vacation find themselves more or less interested in the manifold forms of animal life that they encounter as they scramble over the weed-covered rocks, or walk along the sandy foreshore, or swim and bathe in the sea itself. It is possible that their interest is only transient and that once past the object of inspection their minds turn to other things, and they forget all about it. There are those, even, who pass such things by without taking any note of them at all. The parson, whose introspective mind is busy with his next Sunday's sermon; the merchant, who though on a holiday, has not been able to shake off the cares of business; the lovers, wrapped up in themselves and the enormous seriousness of life's great adventure—these might well miss the crafty crab creeping over the sand for his hole at their approach. But Sonny and Sister will not. See them race for the timid one, missing him by but the merest hair's breadth as he dives sideways into the perpendicular shaft. Watch them dig furiously at the sand till, having reached a depth of a foot or two, they extricate the weird little creature with his eyes popping out of his head, as it were from fright. Triumphantlly they place him in their tiny pail, and carry him away to form part of their collection of dried sea creatures, or to become an inmate of their marine aquarium, there to study more of his ways and appearance.

One's sympathies are with the children, and there is no shame attached to one's becoming for the time being a child again in such matters. There was a time when naturalists were looked upon as a more or less crazy lot of people, of little or no value to the community at large, and more to be pitied and endured than encouraged. But those days are gone, and, though a naturalist in the popular eye is still an old man, with grey locks, spectacles, and a butterfly net, mooning about in the open, poking about in ditches and slimy ponds, or frantically dancing a wild fandango

under the street lamp catching moths and beetles that fly by night, the public has come to realize that there is method in his madness since he has discovered many facts of the greatest value to mankind, while philosophers are forced to look to him for solutions of many of the great problems of nature. Thus the study of animal and plant life has received a great impetus, and year by year we find an ever increasing flood of enchanting literature pouring from the press for our edification and enjoyment. And of all places of interest in which to contemplate the animate works of nature the seashore easily leads.

There are many reasons for this. First of all life by the sea is always abundant and varied. Then there is the theory held by many naturalists that life on this earth probably began at the point where sea, land, and air meet, that is to say, along the littoral of the first great continental masses, wherever they may have been at the dim red dawn of things. Geology tells us that they were not where they are to-day, and that brings us to a third reason why the life of the seashore is so interesting: we see in it a duplication of what was when the geologic strata were in process of formation, and our familiar fossils were laid on the floors of shallow seas or buried in the deltas of rivers for their age-long rest to help us classify, in these days of intensive scientific investigation, the sedimentary rocks in which they occur. Though we may not realize it, it is probable that forms we see to-day are being buried in just the same way as their ancestors of millions of years ago, to form a record, should there be any to read it, a million years hence of life and conditions now prevailing upon the earth.

But such thoughts are, perhaps, a little trying to the mind, especially now that we are making holiday by the sea; so let us turn to something less speculative and more tangible, something that there is no doubt about and that the most tired mind can grasp and hold without undue effort: in short, since we are at the sea side, let us make an intimate study of the animal and plant life of the foreshore, the rocks, the shallow bays, and the deeps beyond, for a wonderful world lies before us.

First of all let us consider for a while the life of the sea itself. Oceanography has in recent years developed into a very important, and almost an exact, science, and not the least important part of it is that to do with the biology of the ocean.

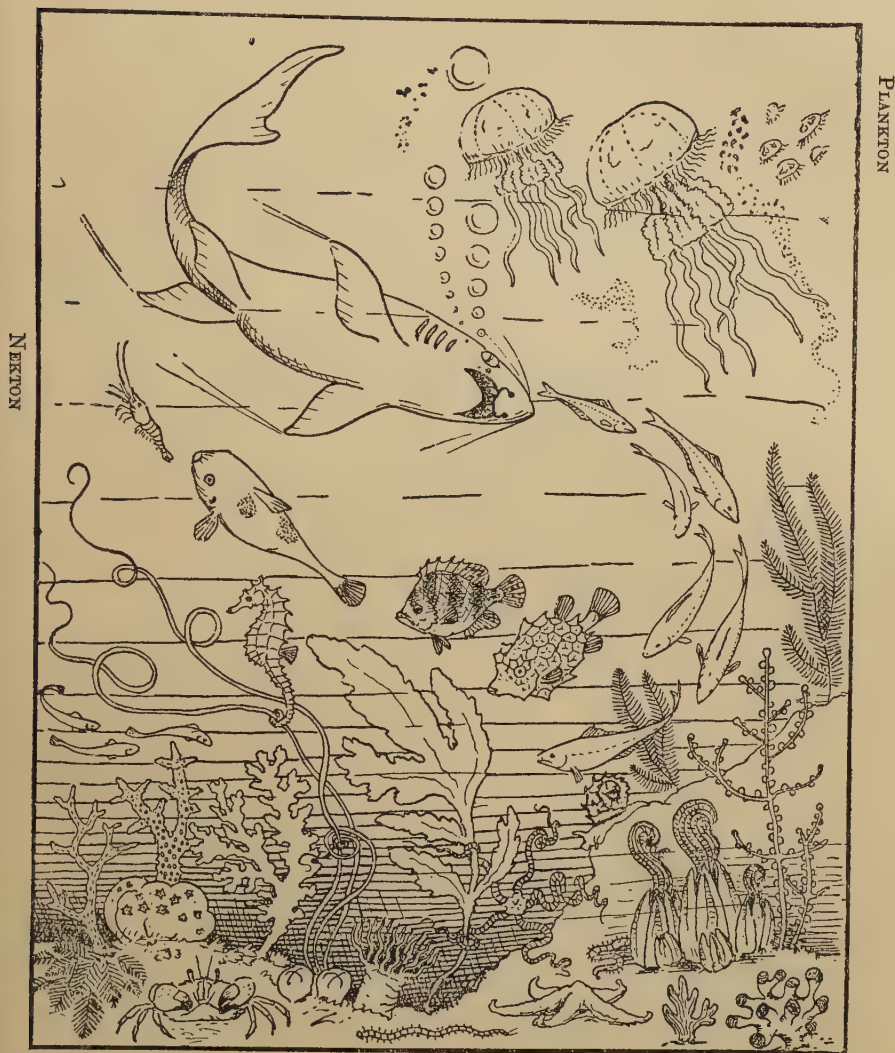
In fact, one might almost consider this the most important branch, since the main utilitarian aspect of oceanography is the knowledge it brings us of one of mankind's greatest food supplies—marine fish. They have realized this in Europe and America, and have established splendidly outfitted stations at various points of vantage to investigate the life histories and breeding conditions of the many important kinds of food fishes, mollusks, and crustaceans, with a view to increasing the supply. They have realized this, too, in Japan, and in recent years the Japanese have added considerably to our knowledge of the marine fishes of the waters of the Orient, especially those round the Japanese, Korean, and Manchurian coasts. But they have not realized it in China, and China in this matter, as in so many others of importance, is still dreaming the dream that she began two thousand years ago, namely that no one could teach her anything. Thus while the fishermen that belong to the great Ningpo Fishing Guild go out with their small fishing boats, and make their catches with line and primitive trawl nets, the Guild forbidding the introduction of steam trawls, Japanese steam trawls visit Chinese waters and make huge catches, which they take back to Japan and sell at an enormous profit, because of the size and quality of the fish they catch.

In order to facilitate the study of animal and plant life in the ocean these have been divided collectively into three great groups, namely the Benthos, the Nekton, and the Plankton. These three terms have nothing to do with the systematic classification of living organisms, but have reference rather to the environment and habits of the animals and plants they include.

Thus Benthos is the aggregate of animals and plants that crawl upon, or grow adhered to, the sea bottom. To it belong all the anchored weeds, or algae, the barnacles and adherent tunicates, all the crawling crustaceans, such as crabs, lobsters, and sandhoppers, all the creeping things, such as starfishes, shelled mollusks, sea-slugs, sea-urchins, and worms, and all such animals as cannot of their own volition move, such as many of the free tunicates. Sea-anenomes, corals, polyzoa, and sponges are all part of the Benthos.

Nekton is the aggregate of all those marine forms of animal life that are possessed of powerful means of locomotion, and which can travel over wide areas of the ocean. Whales, seals,

and the majority of fish, as well as a few lower forms, such as cuttlefish and their relatives, belong to this group. Obviously it cannot include any plant life.



BENTHOS

TYPICAL MARINE LIFE OF THE CHINA COASTAL WATERS

Plankton is the aggregate of animal and plant life that floats or drifts in the ocean, and so is carried about by the action of

currents. To it belong innumerable microscopic plant and animal organisms, the spores of the anchored weeds, and the spawn and young of a great many fish, crustaceans, mollusks, and other kinds of marine animals.

These terms are extremely useful in discussing marine life generally, for they imply at once the possession of certain characteristics as well as the characteristic environment of any animal or plant to which they are applied. The groups of life to which they apply are capable of further subdivision or modification. The Benthos may be divided into (1) Littoral Benthos, that lying between tide-marks on the seashore; (2) Laminarian Benthos, that where the Laminarian seaweeds grow in great jungles, namely, from normal low-tide mark to spring low-tide mark, (3) Shallow water Benthos, that of the more or less shallow coastal waters, (4) Deep sea Benthos, that occurring in deeper water, *i.e.* from 50 fathoms to 2000 fathoms, and (5) Abyssal Benthos, that of the abyssal depths of the ocean below 2000 fathoms. The Nekton is divided, at least as regards its fish element, into (1) Pelagic Nekton, which includes such species as keep near the surface of the ocean, (2) Demersal Nekton, such species as keep near the bottom, but which must not be confused with the Benthos, and (3) Abyssal Nekton, the forms that occur in the deepest parts of the sea. Plankton is similarly divided into (1) Euplankton, the plankton of the upper layer of the ocean, (2) Mesoplankton, that between 100 fathoms and 500 fathoms down, and (3) Hypoplankton, that of the ocean below 500 fathoms.

The coast of China, like that of most countries, when it dips beneath the waves of the sea, forms at first what is known as a continental shelf. This is a somewhat shallow area of the sea, the parts of which nearest the land support the great forests of seaweed, and which contains a very abundant animal life. The edge of this continental shelf seems to lie immediately to the east of the chain of islands—the Japanese Islands, Formosa, and the Philippines—which fringe the coast of China. Thus there is no really deep water that can be said to belong to China, and so we have no abyssal marine fauna to consider, though to the east of Japan lie some of the deepest parts of the whole ocean area, whence some extraordinary forms of animal life have been procured. It may be noticed, in passing, that plant life in the sea can only occur at comparatively small depths, being confined

to a fringe round the land on the continental shelf. There is no such thing as deep sea plant life, since the very life of plants depends upon light, and light rays can only penetrate to a depth of 150 fathoms or so.

While on the subject of marine plant life, which, by the way, is almost exclusively confined to one great group, the *Algae*, it may be mentioned that seaweeds are not nearly as plentiful, nor the masses of growth so extensive as one is accustomed to find round the British coasts, though, as we progress in a northerly direction, and reach the Primorsk coast, algal growth increases rapidly till along the Kuril Islands and northwards we have the great beds of kelp, so characteristic of the shores of the North Pacific. Even along the most northerly part of the Chinese coast line, that is, in the region of Chin-wang Tao and Shan-hai Kuan, seaweed is surprisingly scanty on the rocks that are laid bare when the tide goes out. This, of course, has its effect upon the animal life which, in some elements of normal littoral life is correspondingly scarce. A rock-pool on the China coast will as a rule compare but poorly in the abundance and variety of animal forms it contains with one, say, in such a place as the Cornish coast in England. Nevertheless, there is sufficient of interest in even a Chinese rock-pool to make a close study of its contents well worth while.

If we commenced journeying from the Okhotsk Sea to the Gulf of Tonkin following the coast line and examining the animal life of the sea as we went, we should find that it underwent some very marked changes. In the Tartar Straits and the North Japan Sea the marine fauna is distinctly northern, and, in its elements, would be found closely to resemble that with which we are familiar in Great Britain and North America. The herring and cod are numerous, as also are the flat fishes, not to mention many forms of sculpin and blenny. But once we got round the Korean Peninsula we would notice a great difference. The cod would be found to be almost non-existent, the herring absent altogether, and flat fishes very much fewer, both in individuals and species. The fishermen's nets would contain other forms of a more tropical kind. Sea-breems, corvinas, hairtails, sea-bass, garfish, pomfrets, and the like would be the prevailing forms found. The Korean Peninsula seems to form a sharp dividing line between two very distinct marine faunas, a fact probably due to the differences of temperature in the waters to either side of this arm of land, brought about

by the influences of the prevailing currents. The sea to the west of Korea is warmer than that to the east, for the simple reason that in the former area the prevailing currents are from the south, while in the latter there is a cold current following the Korean coast line whose origin is the Okhotsk Sea. From the Pechili Gulf southward the marine fauna is virtually of one type, though, of course, as we progress southward it will be to find new and interesting forms occurring, and more purely tropical species predominating. Though examples of this peculiar distribution have been drawn only from the fishes, it applies equally well to other branches of animal life. The range of certain marine mollusks will be found to extend from the Pacific as far south as the south-eastern coast of Korea, where it abruptly ceases.

The science of oceanography has taught us that life is most abundant in the Benthos, and of the Benthos that part known as the Laminarian Benthos is said to be the richest. Along the China coast, however, there does not appear to be a true Laminarian belt, the great ribbon-weeds, from which this belt gets its name, being conspicuous by their absence. Their place is taken by a weed not unlike the gulf-weed of the Atlantic, but which is, of course, one that anchors itself to the rock-bottom instead of being free-floating. Oceanography has also taught us that the Plankton is less rich in animal life in warmer waters than in cold, due it is believed to the fact that for a fall of 10 degrees Centigrade the life of the minute animals that go to form the Plankton is prolonged a thousandfold, so that there will be more overlapping generations. As, then, the seas that wash the shores of China are inclined to be distinctly warm, planktonic life will be less abundant than it is in the Sea of Japan and the Tartar Straits. This, in turn, is probably one of the factors which go to make the larger animals, such as fish and mollusks, of the two areas different.

Our subject is not confined to the forms of life actually in the sea: the creatures that inhabit the foreshore also claim our attentions. And for this reason a few remarks upon the general nature of the coast may not be out of place. Taking it in general the China coast may be said to be a rather rocky one. Everywhere hills, often of granitic, gneissic, or shistose (that is, igneous or metamorphic) formation, come right down to the water's edge, where they form little coves and inlets in which sand or shingle

gathers to form small beaches. In some places long stretches of sand and mud-flats occur, but these are usually at the mouths of rivers. There are very few, if any, of the steep, forbidding cliffs that occur in various places along the British coasts, and so we do not find the immense colonies of nesting sea birds, though, of course, a good many marine birds, such as gulls and shags, or cormorants, nest along the China coast. Mostly the marine birds pass northward to such places as the Kuril Islands, where they are to be found breeding in millions, returning southward at the approach of winter. In spring and autumn the China coast displays a very rich bird life, for the reason that an enormous migration takes place between Siberia and more tropical climes, and the greater part of the migrants follow the coast line.

There is, on the whole, very little mammalian life to be met with on the coasts of China, nor will reptilian life be found plentiful. In this connection it is interesting to note that several kinds of sea snakes are to be found along and off the South China coast. These are easily recognisable on account of the banded appearance, and laterally compressed bodies and tails. Many people consider the idea of the existence of the sea-serpent a mere fable, and in so far as it has to do with a serpent of huge proportions living in the vasty deep they are probably right, but the fact remains that there are true sea-serpents—sea serpents in every sense of the word. These creatures, though entirely air-breathing, actually spend the greater part of their lives at sea, swimming about on the surface, and feeding, one must suppose, upon fish or other marine animals that they find. They are all poisonous. Some of them attain a length of four or five feet. They are tropical or subtropical in their distribution for the most part, but occasionally specimens get carried north by ocean currents, so that one or two species have been reported from off the coasts of the Primorsk in the Japan Sea. Several species have been found amongst the rocks on the Fukien coast.

CHAPTER XX.

COMMON FISH OF THE CHINA SEAS.

We now come to a subject which must be of universal interest. Whether the reader is an angler or not, whether he is a student of animal life, or fails to find anything to attract his attention in the world of animate nature, he at least must eat, and the food set before him at breakfast, lunch, or dinner, must, in consequence, call from him more than a passing remark.

Sea-food forms a very prominent item in the dietary of the human race, and of all sea-food fish is beyond question the most important. Indeed, some races, as, for instance, the Japanese, depend for their protein foods to a very considerable extent upon the efforts of "the toilers of the deep," and the catches of fish made by those who risk their lives on the angry seas.

Thus, however little interested the reader may be in the study of Natural History, he cannot remain altogether unmoved when the subject of discussion embraces marine fishes.

Most people in the home-lands are at least familiar with the common forms of food fish. Even if they could not distinguish between a herring and pilchard—two closely related forms—they know what a cod looks like, and are not ignorant of the appearance of a salmon. The eel has its significance to them, and they know a sole from a plaice. The good house-wife's knowledge will extend far beyond this for has she not "Mrs. Beeton" for her guide in the difficult paths of ichthyology? She will distinguish, with a subtlety beyond the comprehension of a mere work-a-day man, between plaice, flounder, turbot, dab, and lemon sole—all just flat-fishes to her spouse, unless he be an angler. To her, the difference between a whiting and a haddock, or a coal-fish and a pollack, is obvious, while sprats, whitebait, smelts, gurnets, shads, scads, mackerel, hake and ling all have their appointed places in her household economy.

In China it is far less so. In the first place, many of the marine fish that find their way to our table have no common



THE JAPANESE SEA BASS (*Lateolabrax japonica*)

European name by which they may be called. Then the lady of the house seldom visits her kitchen: "olo custom" forbids it. She never sees the fish in the raw and undressed state, and so she comes to know them only by the fictitious name that the cooks, also by "olo custom," choose to call them, and by their quality and flavour.

It was some time before the writer could run to earth and indentify as a shad the famous table fish known in the Far East as *samli*. People, who had eaten *samli* all their lives, had not the remotest idea of its appearance in its natural state. Some hazarded the guess that it was like a salmon, others a carp. None knew it for what it was, the eastern representative of the famous American shad, whose roe is such a delicacy in the land across the Pacific.

Every now and then *real* fresh salmon makes its appearance on the festive board. How many who delight in its succulence and delicate flavour know that it is one of the same species of salmon that swarms up the rivers of North-western America, and which are canned by the million and sent all over the world? The fish sold locally comes from Vladivostok or Northern Japan. Its generic name is *Oncorhynchos*, and at certain seasons of the year the rivers of the Amur and Primorsk provinces, as well as those of Saghalin Island and Yezo, are full of them, hurrying from the sea to the upper reaches to breed. But no true salmon is found in the seas of China Proper.

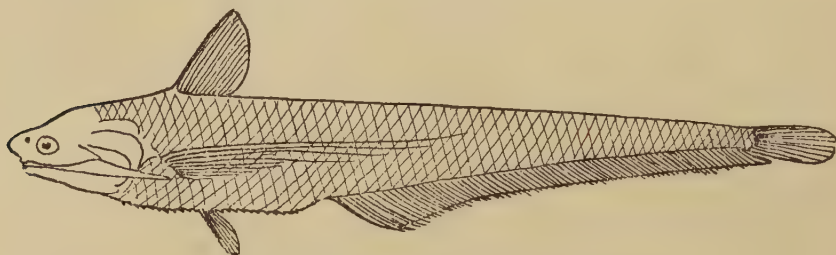
The number of different kinds of fish that infest the coastal waters of China is very considerable. This, after all, is only natural, since the country has a coast line which extends through something like thirty degrees of latitude. It is impossible here to give a list of all these species; we must content ourselves with a brief resumé of commoner or more remarkable kinds.

The herring family (*Clupeidae*) is represented by a number of forms, commonest of which is the spart-like species known to science as *Harengula zunasi*. This fish looks very much like a sardine. The true Pacific herring, (*Clupea pallasii*) seldom, if ever, comes west of the Korean Peninsula, though it occurs off the Amur and Primorsk Coasts in great shoals, as does its Atlantic congener, (*C. harengus*) in the North Sea and off the coasts of Norway.

Closely related to the herring family is that of the anchovies,

(*Engraulidæ*), and here again a number of forms are to be found in Chinese waters. Some of these are rather remarkable in shape, as, for instance, a species called *Coilia ectenes* in which the body is long and tapering with the anal fin extending the whole length of the tail as far as the caudal fin. The pectoral fins have extremely long, thread-like rays. *C. nasus*, a closely similar form, has a shorter anal fin.

The cod family, (*Gadidæ*) is not well represented in these parts. This whole group of fishes, which includes the pollacks, haddocks, lings and rocklings, is characteristically northern in its distribution, its members occurring in the colder seas and parts of the ocean of the northern hemisphere. As a matter of fact, the Pacific cod (*Gadus macrocephalus*) has been recorded from off Port Arthur, but mostly this species, like the herring, does not extend west of Korea.



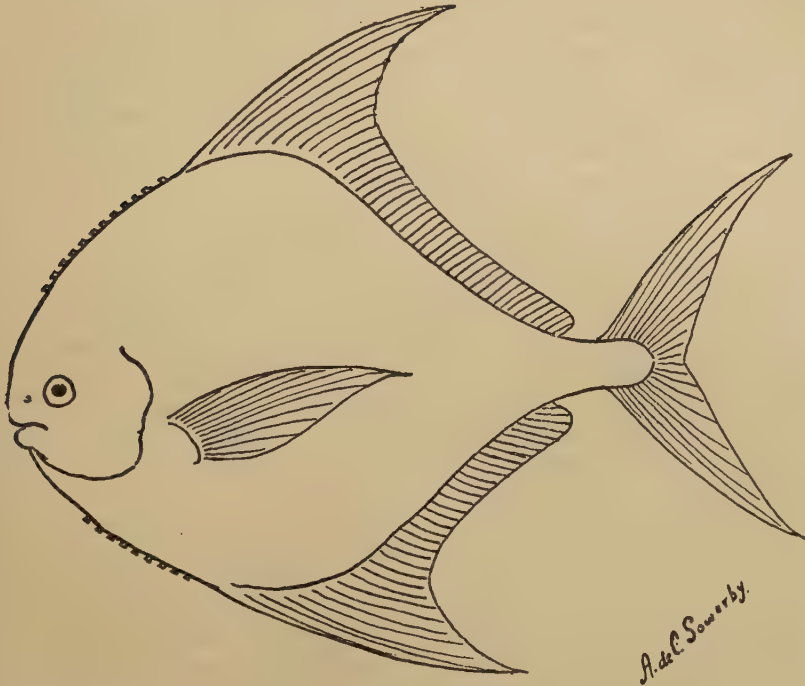
THE LONG-RAYED ANCHOVY (*Coilia ectenes*)

There are a number of flat-fishes—families *Pleuronectidæ* and *Soleidæ*—to be found in our coastal waters, but they are neither very numerous nor varied in comparison with what they are further north. In the region of the Okhotsk Sea and other parts of the North Pacific there is a very great variety of flat fishes. Two soles are fairly common, one a large species known as *Areliscus rhomaleus*, and the other the beautiful banded sole. Of these, the former is the species that commonly finds its way to the dinner table. It is of a plain sandy colour, and reaches a length of two feet and more. The latter is banded sandy and dark grey-brown, the tail fin being yellow with black spots.

The grey mullet (*Mugil cephalus*) is a very common species, and one which is important as a food fish. It is exactly the same species as that which occurs in British waters. The young may be seen in numerous small shoals in shallow water round rocks

at seaside resorts. The adult fish is taken well off shore in deeper water.

As a matter of fact, the young of a great many sea fish may be found close in shore and even in the estuaries of rivers. Amongst these are the pomfrets, of which *Stromateus argenteus* is the commonest form, the gar fish (*Hemiramphus sajori*), the corvinas, *Corvula argentata*, *Collichthys fragilis* and *C. niveatus*,



THE POMFRET (*Stromateus argenteus*, Bloch)

and the sea bass (*Lateolabrax japonica*.) The last is an interesting species, being a true bass, silvery in colour spotted with black. It affords excellent sport with a rod and line. Sometimes it is found far up the estuaries of rivers and even in inland ponds in low-lying districts. There is no reason why this fish should not be introduced into inland ponds and creeks, where it would doubtless thrive and afford local anglers splendid sport. It attains a good size and weight and is excellent eating.

The young of the gar fish has recently been taken in the creek at Henli.* This fish may readily be known by its slender body and long "beak." Only the lower jaw is prolonged, however, by which fact the species may be distinguished from the much larger gar-pike (*Belone*) and saury (*Scombrosox*), in which both jaws are elongated.

Collichthys fragilis and its congener are better known to Europeans out here under the name of "Chefoo Herring," and is considered a special delicacy when in roe in early summer.

The larger members of the family *Scianidæ*, corvinas, maigres, and the like, are extremely abundant in Chinese seas, and form an important part of the food fish of the natives. They are gracefully shaped fish, variously coloured, brown, yellowish, or greyish, and have rounded tail fins. The common name for them out here is cod, and as such they are served at table.

The pomfret is well known as a table fish in Shanghai, its deep, laterally compressed body rendering it unmistakable.

Another fine food fish, and one which affords good sport to the angler, is the gilt-head, a close relation of the famous sea-bream of British waters. There are several species belonging to the genus *Pagrus*. Some are blackish in colour, others red or pink. All have very large heads and long fins. The Chinese name is *Ta-t'ou Yu*, which means the "big-head fish." In Japan these fish are called *Tai*.

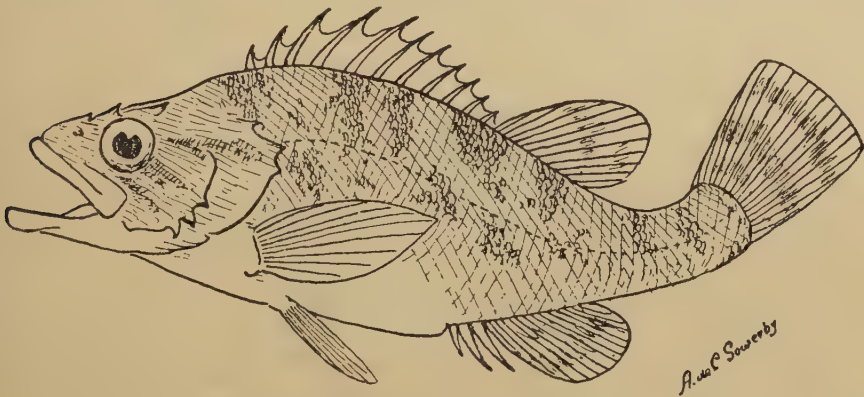
More than one member of the gurnard family (*Triglidae*) are to be found off the coasts of China, but the commonest is *Lepidotrigla microptera*, which means the small finned, scaled gurnard. This is of a dull sandy colour. A more beautiful form is *Chelidonicthys kumu*, which has very large pectoral fins, and is brightly coloured. The gurnards may be known by their ugly heads, which somewhat resemble that of a bull-frog. A fish that looks like a flattened out gurnard is the flat-head (*Platycephalus insidiator*). This species frequents inshore shoal water, and is exactly the colour of the sandy bottom that it inhabits. It is closely related to the members of the goby family (*Gobiidae*), of which a number of peculiar forms are to be found inhabiting rock pools and shallow waters in the neighbourhood of rocks along the coast line. A small species called *Tridentiger bifasciatus*, or

*A popular watering place on a canal or creek not far from Shanghai.

the two-banded goby, is extremely common. Rarer and more interesting are *Ranula fimbriidens* and *Tanioides abotti*, both described from Port Arthur on the South Manchurian coast. The latter may be recognized by its peculiar fins, the dorsal and anal ones extending the whole length of the body and tail, and being joined to the caudal.

Amongst the rocks, too, may be found a bass-like fish called *Sebastes inermis*. Its popular name is the brown rock-fish, and it is a member of the group to which the well known Norway haddock of home waters belongs.

The rock-fish may be caught readily with a line baited with a worm, or piece of meat, but care should be taken in handling it as



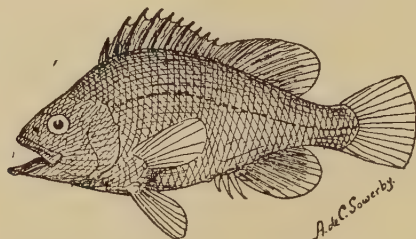
THE ROCK-FISH (*Sebastes inermis*)

its fin rays are stout and sharp, and the fish knows how to make good use of them.

Along the shore, just where the waves break, one may frequently see what appear to be small pieces of blackish seaweed drifting to and fro. As a matter of fact, these are often small fish of a very remarkable nature. They are deep in the body, blackish-brown in colour, with transparent colourless pectoral and caudal fins. They thus exactly resemble a piece of the frond of the common brown sea-weed of the China coasts. When alarmed they have a number of ways of escaping their pursuer. If there is a frond of weed near by they dash into it and are lost to view. If rocks occur they swim up to them, their body colour suddenly changes, and they become banded sandy and dark brown so as to

harmonizes with their surroundings. If no shelter offers they change to a uniform sandy colour, when they become almost invisible against their sandy background. The writer caught a number of these small fish and kept them in captivity to watch these changes of colour, and seldom has he been more entertained. Specimens sent to the Smithsonian Institution have been identified as *Diagramma cinctum*, T. & S., a species which attains a comparatively large size. Thus the small specimens which inhabit shoal waters can only be considered as the young. The adult fish keeps to rocky areas.

The inshore shoal waters, as already indicated, form a very good hunting ground for the ichthyologist, especially during the summer months, for then the young of all kinds of fish that otherwise occur only in deep water are to be found. Besides these, there are a number of species that have their permanent home in



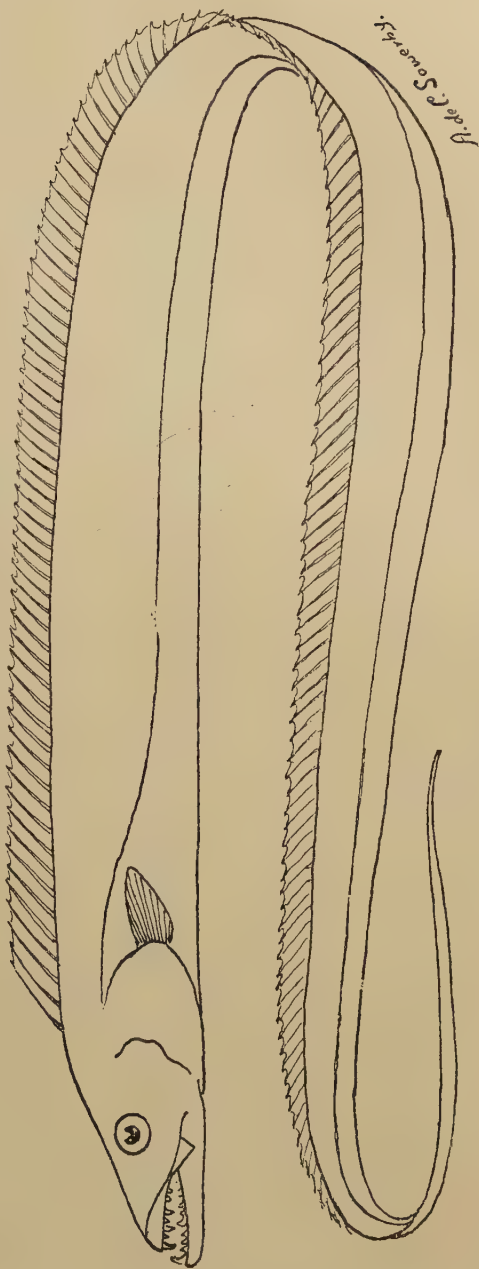
THE SHOAL FISH (*Diagramma cinctum*, T. & S.)

these parts. The little sea-horse (*Hippocampus*) is one of these, and is to be looked for where beds of "sea-grass" (*Zostera*) occur. The habits of the sea-horse are very interesting. In swimming it holds its head semi-erect, slightly forward, while the long, prehensile tail stretches straight out behind. On reaching some weeds or sea-grass the creature assumes an erect position, anchoring itself by curling the tip of its tail round a stem or spray of the weed.

Closely related to the sea-horse are the pipe-fishes. One form, *Fistularia starksi*, has the head and snout almost as long as the rest of its body, its tail-fin being forked with a long ray extending from the middle of the fork. Another form, *Syngnathus schlegeli*, also occurs. This is a much larger species. These fish are interesting in that the eggs of the female are transferred to a brood-pouch in the male, where they are incubated. The male sea-horse is similarly nurse to the family.



THE HALF-BEAKED GAR FISH (*Hemiramphus sajoi*)



THE HAIR-TAIL (*Trichiurus japonicus*)

One should not neglect to mention the mackerel family (*Scombridæ*), which is represented in our region by a true mackerel (*Scomber japonicus*), and the tunny (*Thunnus thunnus*). Closely related to these are the horse-mackerels, or scads (*Caranx*), species of which are found in the China seas, and the hair-tail (*Trichiurus japonicus*) which is a long, silvery, ribbon-shaped fish, well known as an important food fish amongst the natives.

Amongst inshore fishes are to be found several members of the puffer family (*Tetodontidæ*), whose chief peculiarity is that they have the power of blowing their bodies out with air sucked in through the mouth. The gill openings are very small, and apparently form a sort of valve, preventing the air from escaping. As soon as one of these fish is taken from the water it begins to puff up till it resembles an inflated balloon. Placed in the water



THE SPOTTED PUFFER (*Tetraodon ocellatus*, Osbeck)

again, it floats helplessly upside down. There is a reason for this. The puffers are closely related to the porcupine fish (*Diodon*) which have spines all over the body, and when the fish is blown out, like the puffers, these spines stick out and form a serious obstacle to any larger fish that might prey upon it. In the puffer the spines, though present, are very small. The commonest of the puffers is a species that has two large, dark spots on its back. These fish escape from their pursuers by burying themselves in the sand, an operation they do with such rapidity as to seem to vanish into thin air (or water!).

Other related species are the mailed *Lactophrys*, the file-fishes, the trigger fishes, and the well known sunfish. The members of the whole group are characterized by their strong teeth, and very



THREE SPECIES OF TRUE EEL, TWO OF WHICH ARE FOUND IN ORIENTAL WATERS

Anguilla bengalensis (top), *A. anguilla* (middle: the common European form), and *A. japonica* (bottom) = *A. pekinensis*. Dr. J. Schmidt, of Copenhagen, has been carrying on a search for the spawning grounds of the true eels, and any information concerning either of the two Oriental forms here depicted will be of the greatest value.

small mouths and gill-slits. Many of them are armed with terrible spines as a protection against their enemies.

Besides these, there are numerous very remarkably shaped fish, which, however, are not very common, and are seen but seldom, though, if one keeps a close watch upon the activities of the local fishermen, they may be secured whenever they do turn up for a few cents, since they are mostly non-edible.

Eels are to be found; a large conger with pointed jaws, and some brilliantly marked *muraenas* being common along the south and southeastern coast.

Since a fresh-water eel (*Anguilla japonica*)* is found in the rivers of China, it may be mentioned here, for, as is well known, the fresh-water eels, contrary to the habits of most fish, migrate from their homes in rivers and streams to the sea to breed. They undergo a change of form in order to meet the new conditions, namely, a deep sea existence, and then migrate. The journey of the European eel has been traced right across the Atlantic to the Azores: where the Chinese eel goes remains a complete mystery; probably to some deep part of the Pacific. No adult eels have ever been found returning from the ocean, only the larval *leptocephali*, and the immature elvers, as the young of eels are respectively called according to the stage of development they have reached. It was long believed that the lanceolate, transparent larval *leptocephali* represented a distinct species; but finally a *leptocephalus* that was kept in an aquarium developed into a young conger, and the truth was realized.

All the foregoing species belong to the group of fishes with bony skeletons. The group of fishes with cartilaginous skeletons, such as sharks, skates and rays, is well represented. There are numerous sharks, large and small, to be found in China seas, some occurring with considerable frequency close in to shore. Amongst others are several kinds of dogfish, the hammer-headed shark, and in the extreme south, some of the larger and more rapacious species.

Rays, too, are numerous, amongst others being the eagle ray, a form with a very wide spread across the pectoral fins. *Raja meeidervoorti* and *R. kenojei* are two of the commonest species.

Classed with fishes, though far more primitive, or it may be

*The Chinese eel is frequently called *Anguilla pekinensis*, the name given it by Basilewsky, but since it is identical with the eel found in Japan, Schlegel's earlier name *A. japonica* given to the latter is the correct scientific one.

degenerate, are the hagfishes, which are marine relations of the fresh-water lampreys. A species is known in the seas of Japan extending into Chinese waters along the Manchurian coasts. It is known as *Myxine garmani*. These fishes have the horrible habit of attacking other species, and, entering their bodies by means of the gills, devouring them from within by means of the circular, sucker-like mouths, which are armed with cruel, rasping teeth. They are very slimy and unwholesome looking, and are often called slime-eels.

CHAPTER XXI.

CRUSTACEAN LIFE ALONG THE CHINESE FORESHORE

One of the most interesting branches of marine life is that of the *Crustacea*. This class of arthropods (animals with jointed legs) is a very old one, dating back in geologic times to the Lower Cambrian epoch. Fossil crustaceans, in the form of trilobites, are found in some of our very oldest sedimentary rocks, or, rather, one should say, some of our very oldest known fossils are trilobites. These were a form of crustacean not met with in a living state to-day: they died out in the Carboniferous epoch, when the great coal-measures of to-day existed as forests and were in the making. Side by side with the later trilobites, and developing from them, were the ancestors of our modern crustaceans. They were, apparently, all marine, and to this day the group is most strongly represented in the oceans of the world, though numerous forms have invaded fresh-water and even dry land. Out of the early crustaceans developed the insects, but that is another story, as Kipling says, and does not concern us here.

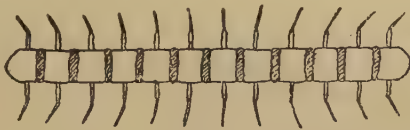
Trilobites were segmented crustaceans with numerous legs, and their chief characteristic, and the one from which the whole group derives its name, was that the body was divided longitudinally into three lobes by two grooves running from head to tail down either side of the back. Trilobites reached a high state of specialization and their zenith, so to speak, was attained in what is known as the Ordovician epoch. Numerous forms have been found in the rocks of China, one of the most interesting of which is known as the bat, or swallow, fossil. In this form the "tail-fan" is enormously and peculiarly developed, bearing an extraordinary resemblance to the conventional Chinese pictorial representations of the bat. A slab of rock containing these fossils appears almost as though it had been decorated with the "bat" design by some Chinese artist. One of the commonest of the "bat" trilobites is known to science under the name *Drepanura premesnili*, and it dates from the Middle Cambrian epoch.

But this is not supposed to be a discussion of the fossils to be found in China; we are about to examine the crustacean life of the China coast. Anyone who likes to take the trouble to pry about rocks, sandy bars, mud-flats, and the mouths of rivers and streams on the coasts of China will soon find himself absorbed in the wonder of the animal life he will discover there. And most prevalent of Nature's creatures in these places are the crabs, shrimps, prawns, isopods, amphipods, and the like—insects of the sea, one might almost call them, since in their variety of form and habits and the sphere they occupy they take the place in the ocean and along the seashore of insects on dry land. Only none of them fly. They flit, so to speak, through the water airily and look like elves and goblins, so strange are they in form.

Crustaceans belong to the Benthos and Plankton. None of them can really be considered as powerful swimming creatures, such as characterize the Nekton, though all are good swimmers, except, of course, the barnacles. Their method of swimming is by numerous appendages situated on the under surface of the body which have become modified into swimmerets or paddles, and by a rapid movement of these a shrimp or prawn may proceed with comparative speed through the water. The word comparative is used because when compared with the rapid dash of a fish the progress of a crustacean is very slow. A few, such as the lobster and prawn, have another method of procedure when speed is required. They shoot backwards by means of rapid forward strokes of their tail-fans. It was to this practice that the student was referring when he described the lobster as "a red fish that swims backwards."

Perhaps it would be well to describe roughly the anatomy of a typical crustacean, for it is conceivable that there are some who will read this whose minds may be a little confused with the various terms used and just what they mean. Let us take a lobster, since most people are familiar with the general appearance of this animal. The body, it will be noted, is divided into two main parts, an anterior non-segmented section which is called the cephalothorax (head and chest) and is covered by what is known as the carapace, and a posterior portion which is segmented and is called the abdomen. The cephalothorax carries numerous appendages, beginning with the eyes and antennae, and continuing posteriorly with the claws, or chelae, and walking legs. The abdomen

carries swimmerets, the last segment bearing the tail-fan, which is a combination of modified appendages. Indeed, theoretically, a crustacean is an animal made up of a series of segments, each with a pair of appendages, only the lobster has gone in for a certain amount of modification of the original pattern, the anterior segments becoming fused, and their appendages specializing along various lines, while the posterior segments remain separate. A crab is even more modified, the cephalothorax broadening out and becoming the bulk of the animal, and the abdomen becoming greatly reduced and tucked away on the under surface. Amphipods, that is, sand-hoppers and the like, and isopods, that is, sea-slaters, woodlice, and their kin, have adhered more to the original type, and are segmented throughout with appendages all closely similar forming simple legs instead of highly specialized organs. Incidentally, it is rather an interesting point to note that this form of architecture—that is, segments and paired appendages—is at the base of most animal organisms from worms upwards. When Nature evolved the worm, she had discovered the secret of how to produce man! Take a man's body and examine its anatomy. The whole structure is built up on the spinal column, which is a segmented rod of bone and other tissues with paired appendages. By specialization and modification, such as we have already noted in the lobster—only much more so—the skull, jaws, arms, ribs, legs, and so on, are derived from what in a creature of more lowly degree would be merely paired appendages. Thus the fundamental architectural plan of most life as we know it on the earth may be expressed diagrammatically thus.—

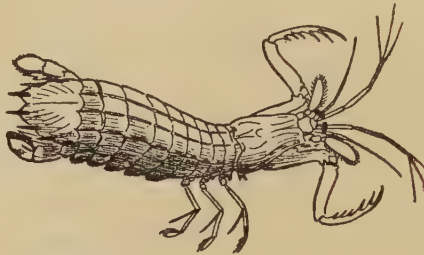


eg. A centipede, or a worm.

But we are wandering from our subject; indeed, we have not really begun to tackle it yet. The lobster, for all we have used him as an example, is not, as far as I have been able to ascertain, an inhabitant of Chinese coastal waters, though a species occurs in Japanese waters, and the same, or another off the coasts of the Primorsk and North-eastern Korea. His place is taken in Chinese waters by a large and very handsome crawfish, or spiny-lobster,

closely related to the British species, but differently coloured. This creature is a marvel of variegated mauve, blue, cream, and green, and it is a frequenter of rocky parts from Chekiang southwards. It may range further north, but I have not come across specimens definitely stated to have been taken further north than Foochow. It is readily distinguished from the lobster by the absence of the large claws, their place being taken by small sub-chelate appendages like walking legs. Sub-chelate, it may be explained, means that instead of the claw ending in two lobes which grasp like pincers, there is only one lobe which bends down upon the penultimate segment of the appendage in the same manner that the blade of a penknife shuts down upon the handle.

Another crustacean of the China coasts that has sub-chelate claws is the squilla, or sea-mantis (*Chloridella oratoria*). In this



THE CHINESE SEA MANTIS (*Chloridella oratoria*)

strange looking inhabitant of the sea the cephalothorax is greatly reduced, the abdomen being proportionately large, especially the tail-fan. The creature owes its name to the fact that its grasping claws very much resemble those of the praying-mantis.

There are numerous forms of prawn to be found in these parts, some of which reach a large size. In May and early June a very large species appears off the coasts in great numbers. This is the form served at table and considered such a delicacy. It is caught by the fishermen in their nets, and sells for as low as five copper cents a pair in the north. It belongs to the genus *Peneus*, characteristic of warm seas, and in which the first three pairs of legs have pincers, or chelæ. Off Japan this species, known to science as *P. japonicus* and on the China coast as the Chefoo prawn, has the colour very highly developed, a regular rainbow pattern shimmering on the creature's translucent body. The Chinese form, probably as a result of the muddiness of the rivers and inshore

waters, is of a dull sandy colour. Another prawn of the China seas is *Palaemon japonicus*, distinguishable by its long rather powerful claws.

In the north a large prawn with very long antennae occurs along the coasts. This is *Palaemon carinatus*, Ortmann, while other species of the same genus, though much smaller, are found in the rivers and streams of the south and east. These are *P. modestus*, Heller, and *P. paucidens*, de Haan. The latter is very numerous round Shanghai, the former in the rivers of Fukien. *Penaeopsis monoceros*, Fabr., is another marine prawn. The extremely long-clawed prawns so common in the waters of the Yangtze Delta and southward belong to the genus *Macrobrachium*, the species common to the Shanghai area being *M. nipponensis*, de Haan, and that found in the rivers of Fukien and southward *M. asperulus*, von Martens. Two small shrimp-like, fat-bodied species are *Caridina davidi*, de Haan, which is common in Fukien streams, and *C. denticulata sinensis*, Kemp, which is very numerous in the creeks round Shanghai. All these prawns are caught and eaten by the Chinese, the smaller ones being dried and used as flavouring in their food.

The prawns, crawfish, and shrimps belong to a group of crustaceans known as *Macrura*, which means "large-tails." They are characterized by the development of their abdominal region. The crabs, on the other hand, are placed in a group called *Brachyura*, meaning "short-tails." Between the two groups comes a third, *Anomura*, which includes the hermit crabs, stone-crabs, porcelain crabs, and other forms in which the posterior pedal appendages are more or less suppressed or absent. These groups are classed together in the order *Decapoda*, or "ten-legs", and if one examines any of their members one will find that there are five pairs of pedal appendages (including the large claws) on the cephalothorax, except, of course, in the hermit crabs in which some have disappeared, apparently through degeneration.

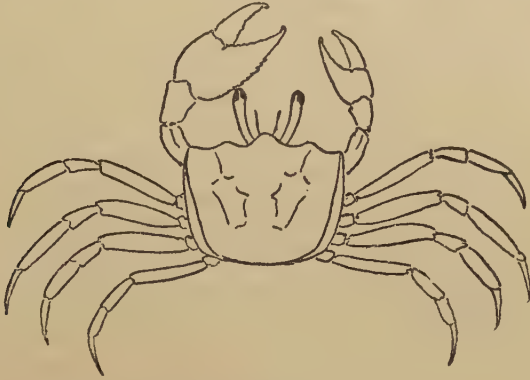
The crabs to be found along the Chinese littoral are numerous and varied. A very common form, *Hemigrapsus sanguineus*, frequents the crevices of rocks, where it may be discovered when the tide goes down. This species has thick powerful claws. The large blue and purple species that is so common in rock-pools and amongst the rocks generally, though keeping always in the water, is known as *Charybdis japonica*. It has its counterpart

almost exactly in the coastal waters of the British Isles in *C. depurator* (by some zoologists the generic name *Portunus* is used for these species). An examination of this crab reveals the fact that its hindermost pair of legs are flattened to form paddles: the species is a good swimmer. Related to it is the pelagic crab *Neptunus trituberculatus* the species above all others that the Chinese consume as food. This handsome purple creature may at once be recognized by its slender claws and the fact that the carapace is drawn out laterally into two prominent spines. This crab is probably the fastest swimmer of the whole tribe, and might almost be included in the Nekton of the ocean, for it is found swimming near the surface out at sea, and so cannot be included in the Benthos, while it can hardly be considered a drifting animal, and therefore does not belong to the Plankton.

Another swimming crab, one in which all the legs have become flattened into paddles, is the little sand-loving species known as *Matuta planipes*. Keeping to the sandy bottom just beyond the line where the waves break, this crab, at the approach of danger, buries itself with extraordinary speed in the sand. It is of a yellow colour, and is beautifully veined all over with a network of delicate red-brown lines and spots. It is exquisite, and may well be considered as our most beautiful species.

Yet another crab that has paddle feet and buries itself in the sand when threatened with danger is common along the China coast. This is known as *Orithyia sinica*. It was originally described by the great Swedish naturalist Linnè (Linnæus) in a botanical work called *Mantissa Plantarum* in 1771 under the name *Cancer sinicus*. For a long while zoologists have looked upon *Cancer sinicus* as a lost species, though it was known all along under the name *Orithyia mamillaris*. Recently, on the strength of specimens sent by me to the Smithsonian Institution, Miss Rathbun, one of the leading authorities on crustaceans to-day, has been able to identify *Cancer sinicus* of Linnè with *Orithyia mamillaris* of Fabricius, and so clear up the mystery surrounding the former. *Orithyia sinica*, then, is the correct name for this crab, which may at once be recognized by the two large round red dots on the back, which, bearing an undoubted resemblance to the human mammae, gave the creature its synonym of *mamillaris*. In the shape of the body this species somewhat resembles the spider crab (*Maia squinado*) of British waters.

When the tide goes out the whole of the flat sandy reaches anywhere along the China coast will be found to contain numerous burrows, round shafts going almost vertically down. These are the holes of a species of burrowing crab, *Ocypode ceratophthalma*, specimens of which may be seen running rapidly over the sand. They have eyes on long stalks, which, standing erect, give the little creature a very peculiar appearance. All round the mouth of the burrow are little balls of sand. These have not, as might be supposed, been brought up from the burrow during the process of excavation, but have been scraped up from the surface of the flat, the crab, apparently, finding some form of food in the sand as it scrapes it up. If a jellyfish happens to get stranded, however, these burrowing crabs gather round and



THE SAND CRAB (*Ocypode ceratophthalma*)

quickly devour it. They are excellent scavengers, and help to keep the beach clear of decaying animal matter.

Several other burrowing crabs are to be found, notably a couple of species that nearly always occur on tidal mud-flats at the mouths of rivers and streams. One of these, *Macrophthalmus japonicus* has the body drawn out laterally, the legs and body being covered with stiff hairs, and the large chelae, or claws, peculiarly shaped, resembling surgical pincers that are bent at the ends. Such forms of crab represent a stage in cancerine life in which a marine environment is being exchanged for a freshwater one or even a terrestrial one. It is but a step from them to the river crabs (*Potamon*), some forms of which may actually be found under stones in woods at considerable distances

from water. There are several groups of crustaceans in which the transition from marine aquatic life to terrestrial conditions may be observed actually in the process to-day. The isopods (order *Isopoda*), for instance, are represented in the deep sea, in shallow seas, as parasites on fishes and other crustaceans, along the shoreline, in fresh-water, in subterranean streams, and on dry land. The littoral species is the sea-slater (*Ligia*), which may be seen running, sometimes in swarms, over the rocks. The well known woodlice, so common under stones and dead logs, are terrestrial isopods. *Idotea*, a species of which has been described from Chefoo, is a typical marine form.

Many other crabs have been secured by the writer in various parts of China, and these have been identified at the United



THE MARSH CRAB (*Macrophthalmus japonicus*)

States National Museum. Amongst them are river, shore, rock and marsh inhabiting species. Besides the large marsh crab already mentioned there are several others. One, a very hairy species, is known as *Macrothalmus tomentosus*, Eydoux & Souleyet, while another, *M. dilatatus*, de Haan, has the claws of a brilliant red colour. *Paracleistostoma cristatum*, de Man., closely resembles it, but is found in streams adjacent to marshes. Along the coasts of the south-east, wherever there are mud flats, a fiddler crab (*Uca arcuata*, de Haan) is abundant. This species may be recognized at once by the enormous size of one of its claws. The sand crab of the same area is *Ocypode stimpsoni*, Ortmann. What may be called land crabs are found in abundance along all the creek banks of the low-lying areas of the east from the Yangtze Delta

southward. These crabs live in deep burrows, whence they sally forth at night, or in day time when all is quiet, in search of prey. They have very powerful claws. There are several species, namely *Sesarma intermedium*, de Haan, *S. neglectum*, de Haan, and *S. dehaani*, M.-Edw. The last has light coloured claws, the others reddish claws and body.

There are numerous fresh-water crabs which may be called river crabs to distinguish them from the others. The largest of these is *Eriocheir sinensis*, M.-Edw., and it is the crab most commonly eaten in China, except possibly the pelagic swimming crabs of the genus *Neptunus*, or *Charybdis*. Other river crabs are *Potamon denticulatus*, M.-Edw. and *P. dehaani*, White, both much smaller than the foregoing.

A peculiar crab found on the northern shores has the body very round and shiny, with the head part slightly pointed. It is known to science as *Philyra pisum*, de Haan. Finally there is the very interesting pea crab (*Pinnotheres pisum*), which is found only inside oyster shells, harbouring in the gills of the oyster. Its body is as round and about the size of a ripe pea, hence its name. I have secured it several times in oysters, said to come from Dalny on the South Manchurian coast.

In Japanese coastal waters occurs the giant spider crab (*Macrocheira kaempferi*). This is the largest known crustacean, having a span across the claws of upward of ten feet.

Many other species of crab occur on the Chinese coast, but they cannot be mentioned here through lack of space.

But before leaving the *Decopoda* note should be taken of the hermit-crabs, several species of which are found on our coasts. As is well known, these crustaceans have the habit of occupying the empty shells of mollusks. They are amongst the most interesting of all crustaceans, since they seem to betray an intelligence worthy of far higher organisms. What, for instance, are we to make of the fact that one species of hermit-crab deliberately captures a sea-anemone and makes it adhere to the shell it is occupying, thus providing a splendid camouflage? And the extraordinary intelligence shown during a battle between two of these crabs for a shell, surely it is an indication of something more than mere instinct? It may be noted that amongst crustaceans generally what appears to be reasoned action is always being met with, so we need not be so surprised at the hermit-crab.

A good example of the apparent reasoning intelligence of crustaceans is to be found in the spider crab (*Maia squinado*) of our British coasts. This species deliberately fastens pieces of loose seaweed to the hairs all over its body and legs thus effectually concealing itself as it lurks amongst the weeds on the sea bottom. A small tropical crab called *Melia tessellata* invariably carries round a small living sea-anemone in each claw, because, it is believed, the claws are so small that they are useless in attacking and capturing food, which the sea-anemones with their tentacles procure with ease. It is said that this little crab shows great distress if the sea-anemones are removed. What is known as commensalism (mess-mating) is very common amongst crustaceans, as also is symbiosis (two different organisms living together for the mutual benefit of both). Parasitism is also common, though in this case extreme degeneration is usually the result.

There are numerous different species of parasitical crustaceans which should be mentioned here. A species of isopod occurs in the China seas which has the habit of attacking fish and feeding on them. Its bite is very painful. This is *Cirolana borealis*. The members of another genus, *Cynothoa*, work their way inside fish where they devour the tissues. The whale louse (*Paracymus*), belonging to the amphipods, is another parasitical crustacean. An isopod that is parasitical on prawns is *Bopyroides*, the female of which gets under the carapace of the victim and causes a large swelling. She may be seen through the transparent shell of the carapace. The writer has a specimen of the long-clawed river prawn (*Macrobrachium nipponensis*), taken in the Shanghai district, with one of these parasites inside the carapace. The fish louse (*Caligus*) is a parasitical copepod found on the skins of marine fishes. *Sacculina*, a peculiar member of the cirripedes, is parasitic on crabs, and may be found as a soft, shapeless lump under the tail on the lower surface of the body. A network of "roots" grows through the tissues of the crab, absorbing the juices.

It is impossible here to mention all the numerous forms of crustacean one may find on the China coast: their name is legion, but there are certain groups that need notice, even in so brief a discussion of the subject as this. Reference has already been made to the isopods. Closely related to them are the amphipods (order *Amphipoda*), or sand-hoppers, which must be familiar enough to



THE JAPANESE GIANT SPIDER CRAB (*Macrocheira kaempferi*). A huge specimen,
10-ft. 3-in. across the claws, which has been loaned to the Shanghai
Museum by Mr. H. H. Read

everybody. The main difference between the isopods and the amphipods is that the former have depressed rather flattened bodies, while the latter have laterally compressed bodies. Otherwise they are much alike. Sand-hoppers are to be found in swarms under masses of weed, either living or dead, as well as under rocks and stones. They are the favourite food of such birds as turnstones that inhabit, during certain periods of the year, the foreshore.

A rather interesting crustacean that looks something like a lobster, but belongs to the *Anomura*—the same group as that to which the hermit-crab belongs—is a little sand-burrowing form of the genus *Callinassa*. Of a white colour, this creature has one claw enormously developed as compared with the other. It burrows in the wet sand about and below low tide-mark, and the dead body may sometimes be found washed up on the beach after a storm.

It may not be generally known that barnacles, those hard shelly creatures that adhere to rocks in such numbers, are really crustaceans. Most people would unthinkingly class them with mollusks. Indeed, up to half a century ago naturalists did so class them, and in most old books on conchology the known barnacles are listed and described. It was an interesting discovery when it was found that the larva of the barnacle closely resembled that of certain crustaceans, and it was not till then that the truth concerning these remarkable creatures was realized. Passing through two free-swimming stages—the barnacle larva finally comes to rest on some suitable surface, where it becomes attached by its head, and there it remains for the rest of its life, growing but degenerating, and becoming covered with a calcareous shell. The segmented tuft that may be seen protruding from the shell represents the legs, and that is about all of the anatomy one can make out without a very close examination.

Barnacles are fairly common on the rocks along the coast in these parts, some very large and beautiful forms being found in deeper water. One form, *Coronula diadema*, occurs partially embedded in the skins of whales, and is very common in the seas of China and Japan. What are called acorn-shells, or stalkless barnacles (*Balanus*) are very common on rocks exposed at low water, while a stalked form, or goose barnacle, *Lepas anatifera*, is found below low tide-mark.

In conclusion it may be remarked that one of the chief components of the Plankton is formed by crustaceans. Whether the

Plankton of Chinese waters has ever been properly examined, or, if it has, whether reports have been published upon it, I am not able to say, but there is not much likelihood of its being very different from that of other parts of the ocean in the same latitude. Planktonic crustaceans are, of course, very minute, and mostly they are primitive. To this group belong the copepods (*Copepoda*), the ostracods (*Ostracoda*), and the branchiopods (*Branchiopoda*). Some of the copepods are extraordinary looking creatures with



Cyclops, a fresh-water Copepod



Nauplius Stage of a Barnacle



Conchæcia, an Ostracod

A Young Crab

Calocalanus, a free-swimming Copepod

CRUSTACEAN ELEMENTS OF THE PLANKTON

(Partly after Calman)

their peculiarly shaped bodies and their remarkable and numerous appendages. Other planktonic crustaceans are the larvæ of larger forms, such as belong to the Benthos. These are often as remarkable to look at as the copepods, it seeming almost incredible that they should change to such an extent as they become adult. Indeed, so different are the larval stages of many crustaceans from the adult that but comparatively few of them have been identified. In connection with these minute forms mention should be made of the small fresh-water crustaceans such as the water-flea (*Daphnia*),

Cyclops and *Estheria*. These may be said to belong to the fresh-water Plankton. They are very numerous in China.

It will readily be seen by the reader how vast and interesting a subject the world of *Crustacea* is, and it is hardly necessary to add that a great deal of work in this branch of zoology is waiting to be done on the China coasts.

CHAPTER XXII.

SOME MARINE MOLLUSKS OF CHINA.

In the preceding chapters dealing with the marine life to be encountered along the Chinese coasts, we have dealt with crustaceans and fishes. It is now proposed to discuss the very large and important group of animals known as mollusks, or *Mollusca*, to give them their correct scientific name. To the average reader these will be classed generally under the term "shell-fish," which in the popular mind also includes the crustaceans. The mollusks, however, are very far removed from the crustaceans, while they are not fish at all, so that the name "shell-fish" is hardly one to be recommended. Everybody is familiar with such common forms as the snails, oyster, clams, cuttle fishes and the like, all of which are included in the great phylum *Mollusca*, so that the latter needs no definition. For the sake of the uninitiated, however, a short account may be given of the classification of mollusks, since it is always easier to understand a subject if it is dealt with systematically. The mollusks then are divided into five classes, namely, *Cephalopoda*, *Gastropoda*, *Amphineura*, *Scaphopoda* and *Pelecypoda*. Of these, the *Cephalopoda* (squids, cuttle fishes, octopods, etc.), the *Gastropoda* or gastropods (snails, whelks, limpets, etc.), and the *Pelecypoda* or bi-valves (oysters, clams, mussels, etc.), are the three main groups, *Amphineura* and *Scaphopoda* being intermediate classes between *Gastropoda* and *Pelecypoda*, and containing but few species. We may deal with these first.

That class *Amphineura* contains the chitons, or mail-shells, in which the animal is very much like that of the limpet, adhering to rock surfaces in the same way, but whose "shell" is composed of a number of shield-like sections, or scutes, which articulate one with the other and enable the creature to curl up after the manner of the armidillo. A few species occur along the Chinese coast line, but mostly the chitons are inhabitants of cold seas, where they grow to a large size, some very fine species having been discovered in the region of Kamschatka and the North Pacific

generally. Up to quite recently the chitons have been included in the class *Gastropoda*, but certain differences have warranted their being placed in a separate class by themselves. They may be found at low tide clinging to the under surfaces of loose rocks, or they may even be found sometimes on the upper surfaces of rocks where they feed much after the manner of limpets. In the head of the animal no eyes are present, but in many species the leathery portion of the "shell," which holds the scutes or shields, is furnished with innumerable minute eyes.

The class *Scaphopoda* contains but one family, *Dentaliidae*, commonly known as tooth-shells or tusk-shells, owing to the remarkable resemblance of the shell of the animal to the tusk of the elephant. A number of species are known from the China Seas, but they are by no means common, and are seldom found upon the foreshore. The animal is of a very simple structure, being headless and eyeless, forming an intermediate type between the well differentiated gastropods and the more simple bi-valves.

In dealing with the other three classes we may take the cephalopods first, since they too are not so commonly found along the foreshore. The cephalopods, as the name suggests, are characterized by having leg-like tentacles attached to the head, while the body is usually free from any appendages, being sack-like. In some forms however the body is furnished with a pair of wing-like fins, which enable the owner to keep its equilibrium while swimming usually near the surface of the sea. To this group belong the cuttle fish, squids and loligoes, while to the former belong the well-known octopuses. The class is divided into two orders, *Dibranchiata* and *Tetrabranchiata*, according to whether they possess two or four gills. The *Tetrabranchiata* need not concern us, however, as they contain the members of the *Nautilidae*, typified by the well-known pearly nautilus, which are all tropical in their distribution, and are not commonly found within the vicinity of the China coasts. The order also contains the ammonites, the fossil remains of which are familiar objects in museums, and which belong to bygone periods of the earth's history, filling the seas during Secondary times.

The *Dibranchiata* are divided into two main sub-orders, *Octopoda* and *Decapoda*, according to whether they have eight or ten tentacles. The well-known octopus, of which a number of species occur, especially along the coasts of South China, needs

no description. At any time specimens may be seen in the fish markets of China, where they are sold for food, being considered a great delicacy by the Chinese. A very small form is used by Chinese fishermen as bait for such fish as the sea bass (*Lateolabrax japonica*) and the gilt-head or sea bream (*Pagrus*). Their method of capturing these is rather interesting and unique. The fisherman gathers a quantity of the empty shells of the large gastropod known as *Rapana bezoar*, which is very common along the China Coast, stringing them together on a rope at a distance of a foot or two apart. This chain he lets down into the shallower parts of bays and inlets, anchoring it to a float with a red flag. Periodically he goes out in his boat and drags up the lines, when he finds that large numbers of the small octopods have taken shelter in the cavity of the shells. The common octopus may be looked for in rock pools at low tide, where the creatures lie in wait for their prey, such as small fish, crabs, and the like. It is provided with a peculiar form of syphon, and locomotion through the water is carried on by rapidly expelling the water from this syphon. By this means the octopus can easily overtake the crab swimming, and, enveloping the wretched victim with its cruel tentacles, it draws it towards its mouth, where it crushes it with its parrot-like beak. The octopus, in common with the other members of the *Octopoda*, is provided with a black or dark brown inky fluid, which it ejects into the water when alarmed, thus enveloping itself in a murky cloud, under cover of which it makes its escape.

Far more common are members of the *Decapoda*, of which a number of species are prevalent in the offshore waters, and which form a staple diet in the food of the Chinese. The larger forms are dried and may be seen hanging up in provision shops throughout the whole country. In the decapods there are eight short tentacles and two very long ones, while the body is usually elongate and pointed at its distal end, with broad, triangular fins on either side. The members of the *Sepiolidae*, however, have the body short and rounded, more resembling that of the octopods, while their fins also are rounded. To this family belongs the little *Sepiola*, which is extremely abundant throughout the ocean. The commonest member of the order to be found in Chinese waters is the true cuttle fish (*Sepia*), in which the body is oval in shape, and in which the fins extend down the whole side. It is the

skeletal remains of this form which we find so frequently cast up upon the sands, and which are more generally known as cuttle fish bone. On one occasion, while travelling from Foochow to Shanghai, the steamer upon which I was a passenger passed for hours through shoals of this species, the whole surface of the water being dotted with the white skeletons.

A very common species round the China Coasts is *Loligo subulata*. This is a small loligo.

A point of interest about the members of the *Cephalopoda* is their extraordinary power of changing colour, which they do with lightning rapidity. If an observer watches one of these creatures closely, he will note that its whole body is dotted with spots of various colours which expand and contract. Thus, when the black spots expand to their full extent, the whole animal becomes very dark in colour: when the red spots expand, a reddish blush spreads over its surface: when all the spots shrink to their minimum size, the creature becomes almost colourless.

The class *Gastropoda* is divided into three orders. These are *Pulmonata*, *Opisthobranchiata* and *Prosobranchiata*. Of these we need not consider the first here, since all members of the *Pulmonata* are either terrestrial or fresh-water forms. To this great order belong all the land and river snails that do not have an operculum (i.e., a small, disc-like door to the mouth of the shell), as well as the land slugs. They are characterized by the possession of a cavity for breathing purposes instead of gills, while both sexes occur in each individual. Such land and fresh water snails as are possessed of opercula belong to the *Prosobranchiata* and are particularly interesting in that they represent species that have left the sea at a comparatively recent date. They are closely related to the periwinkles, which inhabit the shore line between tides, and which themselves are actually in the process of leaving the sea for land. In England this group is represented by the peculiar little round-mouthed snail (*Cyclostoma elegans*) on land, and by the well-known river snails (*Vivipara*), bithynia (*Bithynia*) and valve-shells (*Valvata*) in rivers and streams. In China several species closely related to the round-mouthed snail may be found in the southern provinces, while the rivers and paddy fields contain a great many species and varieties of river snails (*Vivipara*), and the mountain streams and rivers contain a number of species of bithynia. As however

I propose to deal with the land and fresh water snails in due course, we may leave this interesting group and return to the marine forms of gastropods.

The *Opisthobranchiata* include the so-called sea-slugs and pteropods. The sea-slugs are amongst the most beautiful of all the inhabitants of the ocean, displaying a great variety of form and colour. A popular error in China is that the so-called "beche-de-mer," of which the Chinese are so fond, are sea-slugs. As a matter of fact they belong to a totally different group of marine animals, namely, the phylum *Echinodermata*, and are known as *Holothurians*, being related to the star fishes and sea urchins. The true sea-slugs do not commonly form an article of diet, though some are edible. The order to which they belong differs



Rapana bezoar

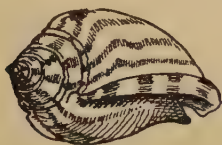
from the *Prosobranchiata*, which contains the great majority of marine gastropods, in that the gills are placed behind the ventricle of the heart, while in the *Prosobranchiata* these organs are placed in front of the heart. Sea-slugs may be looked for in rock pools left behind when the tides are at their lowest ebb, crawling about upon the weeds and rocks. They are mostly carnivorous in habits, feeding upon such animals as sea anemones, tunicates and sponges.

The pteropods are minute mollusks with small, delicate shells, and wing-like fleshy processes from which they derive their name. They are to be found floating about in the sea and form the main article of diet of certain whales and many fish.

By far the greatest number of the uni-valve shells found upon our shores belong to the order *Prosobranchiata*, in the animals of which, as already stated, the gills lie in front of the heart. These are divided into a number of sub-orders, and sections, but

it is impossible to go into details of these here. We may confine ourselves to a discussion of a few of the more interesting and common forms to be found along the Chinese coast line.

In the more northerly parts one of the largest of these shells is *Rapana bezoar*, already mentioned in connection with the small octopods which the Chinese use for bait on fishing. This is a massive shell with a very rough surface and usually of a whitish colour marked with dark brown, the inside of the mouth being a beautiful orange. It is extremely abundant along the foreshore, where it ploughs about in the sandy deposits, seeking its prey. Many of these prosobranchs are carnivorous, their chief prey being the more or less helpless bi-valve mollusks, such as cockles, clams and razor-shells, which usually lie buried in the sands for protection. These carnivorous gastropods are armed with rasp-like tongues, with which they can bore holes through the protecting shells of their prey, enabling them to get at the soft tissues within. This is why so many of the bi-valve shells found scattered



THE HELMET-SHELL (*Cassis strigata*) THE NECKLACE-SHELL (*Neverita ampla*)

upon the seashore have small round holes in them. Such mollusks as the *Rapana* plough their way into the soft sands till they come upon some lurking bi-valve, which is, of course, unable to escape.

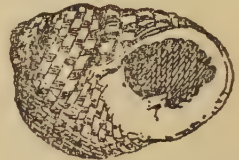
One of the most beautiful of our bi-valves is the Chinese helmet-shell (*Cassis strigata*), whose elegant shape and delicate bands of pale blue and biscuit brown striations make it a most attractive addition to the collector's cabinet. Frequently individuals of this species may be found lying out on the sands at very low tide, where also the large brown necklace-shell (*Neverita ampla*) may be found. The necklace-shell derives its name from the fact that the eggs are laid in gelatinous, collar-like bands, which objects should be familiar to the visitor to the seaside. The necklace-shell may easily be recognized by its form, being smooth and rounded, with a rather large ear-shaped mouth. Specimens attain the size of a man's fist, though these are rare. One frequently finds shells cast up upon the shore perforated in a similar

manner to the bi-valves, which indicates that the necklace-shell itself frequently falls a prey to one of its rapacious relations.

Another large shell commonly found on the shore somewhat resembles our English whelk, being known to science as *Cancellaria spengleriana*. It too is of a beautiful biscuit brown colour, while the whorls are gracefully ridged and turretted. A visit to the rocky areas will reveal a great number of small, thick shelled mollusks congregated in the rocks and fissures. These are



Cancellaria spengleriana



THE TOOTH-SHELL (*Monodonta*)

the young of the species known as *Thais tumulosa*, which takes the place in China of the well-known sting winkles of British coasts, though not closely related to the latter species. The adult form is to be found clinging to the rocks from below low tide mark seawards, and specimens may be gathered by raking the rocks with a net. In the adult form the sharp angles and ridges of the young have almost disappeared, so that by the casual observer the two would scarcely be identified with one another. Other



THE DOG-WHELK (*Nassa varicifera*)

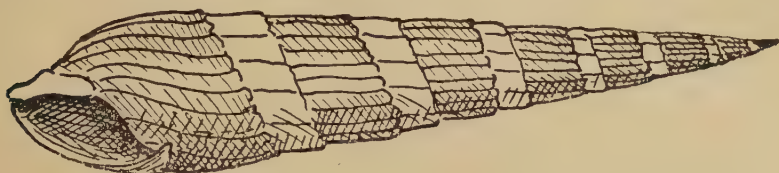


THE TOP-SHELL (*Chlorastoma rustica*)

rock-inhabiting species are the winkles (*Littorina*), tooth-shells (*Monodonta*), the members of the genera *Cerostoma* and *Cantherus*, and the dog-whelks (*Nassa*). Of these a member of the last, *Nassa varicifera*, is extremely abundant. It is a beautiful little shell, with a rather long spire, well defined ridges across the whorl, and usually a thick lip to the mouth of the shell.

Related to the winkle, but very different in appearance, is the so-called cup-and-saucer limpet, the common Chinese repre-

sentative of which is known to science as *Crepidula walshi*. Specimens may be found lying amongst the litter of other shells along the shore, and at first sight they might be mistaken for the upper half of a common oyster, being rounded, white and laminated. Careful examination, however, will show that on the smooth surface (*i.e.*, inside) occurs a little lip-like excrescence by means of which the animal retains its hold of its shell. The species is closely related to larger forms which occur in the tropics, in which this little lip-like excrescence is replaced by a



THE CHINESE SPIRE-SHELL (*Terebra dussumieri*)

regular cup, the whole shell having the appearance of a cup and saucer joined together, hence the name.

Besides these, a number of very beautiful spire shells are to be found, of which *Terebra dussumieri* is, perhaps, the most attractive. It reaches a length of about four inches, is gracefully grooved across the whorl, and banded dark brown and buff, the two bands following the direction of the spire. Several of the wentle traps (*Scala*) also occur in Chinese waters, and may be found occasionally on the shore. Of these, the so-called Chinese



WENTLE TRAP (*Scala*)

wentle trap (*Scala scalaris*) is perhaps the most interesting, since at one time a good specimen commanded as much as £40 in the market from collectors in Europe. Nowadays, however, specimens may be purchased for a few shillings. In this species the mouth is rounded and has a very heavy lip, while the spire is heavily ridged across the whorl. A more common form of *Scala* is one to be found in the mouths of small streams. Its scientific name is *S. acuminata* and it may readily be recognized by the absence of any ridges on the whorls, and the somewhat rounded form.

Another pretty spire shell is known as *Lampania aterrima*. This is a small form about one inch in length, which is extremely abundant amongst the rocks and at the mouths of small streams.

Most people are familiar with the so-called top-shells (*Trochidæ* and *Turbinidæ*) of which a number of species are to be found along the Chinese coast. Of these the two commonest forms are known to science as *Chlorastoma rustica* and *Umbonium bestiarium*, the latter being found in great numbers in rock pools at low tide, while their empty shells occur in deep accumulations in nooks and amongst the rocks at about high tide mark. In this species the spire is very flat while the whorls are delicately striated in various shades of brown, purple and pink. *Chlorastoma rustica* is a somewhat larger species with a more pointed spire. In South China some very beautiful members of this family occur, many of which attain a considerable size.



THE MONEY COWRIE (*Cyprea moneta*)

Mention should be made of the beautiful little dove-shell (*Columbella mertensi*), which is extremely abundant in rock pools. In this species the spire is rather long, while the colour varies. In some specimens it is almost black striated with white; in others the black is represented by yellowish-buff or light brown. The shell is a little over half an inch in length.

An interesting group of shells is that of the cowries, owing to the fact that a certain species, *Cyprea moneta*, has been used since prehistoric times as a medium of exchange and barter. Recently this species has been found in certain prehistoric sites in China by Dr. J. G. Andersson, working under the auspices of the Geological Survey of China, and he is very anxious to secure specimens from the China coast, so as to correlate its present distribution with its use in prehistoric times in order to determine

the trade routes of those by-gone days in Asia. The accompanying drawing is of a cowrie, identified as *Cyprea moneta*, from the now famous Yang Shou site in Honan. Closely similar forms occur along the Fukien coast, where there are several species.

The last group of gastropods which call for mention here comprises the well-known limpets, in which the shell has no spire. Though very numerous along the British coast line, members of this group are far from common in our regions. A careful search along the rocks, however, will reveal one or two very small species, the commonest of which is a species of *Patella*. Fully grown specimens measure about half an inch in diameter. The limpets should not be confused with the syphon-shells, which closely resemble them in form. These belong to an altogether different group, a careful examination of an empty shell showing a slight groove on the inner surface of one side. This groove is caused by the presence of a syphon in the animal, hence the name. A common species along the China coast is *Siphonaria fuliginata*, and the uninitiated would most certainly mistake it for some form of limpet.

In dealing with the bi-valves, or *Pelecypoda*, we have an enormous number of species which should be considered. Owing to lack of space, however, it is only possible to deal with certain of the more familiar forms. *Pelecypoda* are divided up into a number of orders according to the structure of the gills. In examining such mollusks as the common river mussel, the student will notice that the body contained within the two valves of the shell is symmetrical in the same way as the valves, being composed of a number of flaps which enfold a fleshy mass and what appear to be viscera. The outermost flap is known as the mantle, while those immediately within are the gills, and it may be noticed that they are peculiarly striated. It is according to the number, arrangement, and folding of these gill flaps that the orders are differentiated, but we need not go into the details of these here, contenting ourselves with the enumeration of the various orders. In further examining the body of the mussel it will be found that there is a mouth at the anterior end, while a syphon occurs at the posterior end composed of part of the mantle. A circulating current of water is kept up within the animal, supplying the stomach with food (consisting of minute animals and plants suspended in the water) and the gills with oxygen dissolved

in the water. The large, fleshy mass is the foot, and is used in most cases to assist the mollusk in locomotion. In some, however, such as the piddocks, it is functionless: in others, such as the oysters, almost wanting.

The first order of the bi-valves is the *Protobranchiata*, which contains the little nut-shells and ledas, in which the branchia or gills are of the simplest form. This order is very small and need not concern us.

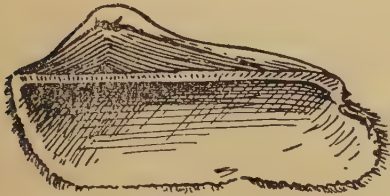
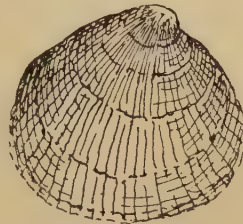
The next is known as *Filibranchiata*, and contains the saddle-oysters, ark-shells, and marine mussels. In these the gill flaps are characterized by having joined filaments, making the gills look something like a grid. The visitor to the seaside will frequently find very beautiful opalescent shells, which very frequently, but erroneously, go by the name of "pearl-oysters." These in reality are the upper (sic) valves of the saddle-oyster, which derives its name from the fact that the lower (sic) valve has a saddle-shaped hole in it, through which a powerful ligament extends from the body of the animal and anchors it to rock surfaces. The use of "upper" and "lower" to designate which valve is meant in this and similar mollusks is not really correct, since they correspond to the "right" or "left" (which ever it happens to be) in bi-valve mollusks that are not so attached. The commonest form of saddle-oyster along the China coast is *Anomia labris*. It is usually of a beautiful pinky-orange colour, and strongly opalescent, the shell being very thin and delicate in texture.

Over all the rock surfaces may be found small specimens of a little black mussel (*Modiolus*), which closely resembles in general appearance the common mussel of British waters. A very much more handsome form, which may be picked up occasionally, is *Modiolus nitidus*, in which the outer surface of the shell is a rich brown colour, while the inner surface is beautifully opalescent, the shell itself being very delicate in structure. On this account perfect specimens are not easy to secure, but they may be found after a storm, lying out on the sands at low tide.

A great many different kinds of ark-shell are to be found in China, some of which the Chinese use as food in the same way that clams and cockles are used in England and America. One of the commonest of these is a white, rounded form known as *Arca subcrenata*. It is very common in the mud and sands at the mouths of the larger rivers, where it is gathered in large

quantities by the Chinese and shipped inland to the fish markets. Another common form of ark-shell is *Arca kraussa*. This shell bears a peculiar resemblance to a Noah's Ark, from which fact species of this family derive their popular name. It is to be found chiefly amongst rocks, where it burrows about in the sand and pebbles between the crannies, wearing away its shell in a peculiar manner, so that it is seldom that a perfect specimen is to be secured.

To the *Pseudolamellibranchiata*, our next order, belong all the pectens or scallops, the fan mussels and the common oysters. Of the scallops some very beautiful forms are to be met with, especially in the more southerly regions : in fact it is in this group of mollusks that the most beautiful of all shells are to be found, their delicate shape and marvellous colourings rendering them veritable butterflies of the sea. The simile is not out of place, for the reason that scallops have the power of flitting through the water

THE ARK-SHELL (*Arca kraussa*)THE VENUS-SHELL (*Venus yedoensis*)

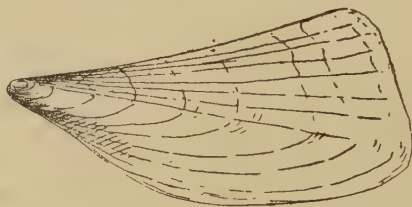
by opening and shutting their valves, and when doing so, they bear an extraordinary resemblance to a butterfly flying about in the air.

Oysters, on the other hand, are invariably anchored to some suitable surface. Along the coasts of North China and South Manchuria, especially the latter, oysters of the species *Ostrea talienwhanensis* attain an enormous size, shells sometimes being found of as much as a foot in length. The common form along the coasts is *O. denselamellosa*. In South China the famous bamboo oyster occurs, a small species which the Chinese cultivate by sticking bamboos into the mud, upon which the young oysters grow. When the latter have reached a certain size the bamboos are pulled up and the oysters taken to the market, where they meet with a ready sale. A very interesting point about the oyster is that the individual is bi-sexual; at one time of its existence being male, and at a later date female.

A very large species of fan mussel (*Pinna*) is to be had along the coasts of South China, from Fukien province southwards. In this species the shell is triangular in shape, the outer surface having a somewhat horny appearance. Specimens of eight to ten inches in length are common.

By far the largest order of bi-valves is that known as *Eulamellibranchiata*, which contains the cockles, clams, fresh-water mussels, tellins, sunset-shells, furrow-shells, wedge-shells, through-shells, Venus-shells, gapers, otter-shells, razor-shells, piddocks and lantern-shells—far too numerous to deal with in detail though one or two may be specifically mentioned.

The large, so-called edible clam, which figures so conspicuously in the menu at Chinese and Japanese dinners, belongs to the genus *Cytherea* (sometimes called *Meretrix*). There are a number of this species occurring along the Chinese coasts. In these the shell is very thick and heavy, smooth on the inner surface, and



THE CHINESE FAN MUSSEL (*Pinna*)

usually beautifully marked with zig-zag, brownish lines, and triangular blotches. The common species are *C. lusoria*, *C. zonorio*, *C. impudica* and *C. petechialis*. Of these the last is the largest, and may be recognized by the absence of any colour markings, while *C. zonorio* is very beautifully marked and is about half the size. The other forms are intermediate between these two extremes.

A bi-valve shell that is very common along beaches, and which must be familiar to all visitors to the seaside is that of the Artemis (*Dosinia troscheli*). In this, each valve is very thick, flat, and of a dead white colour. It is almost perfectly disc-like in shape, so that it resembles a plate. The outer surface is very finely grooved with concentric rings. It attains a size of two inches or more in diameter. It is closely related to the Venus-shells, of which *Venus yedoensis* is the common form on the China coasts. In this the valve is deeper than in the

Artemis, more like that of the clam. Another related and very common form is the carpet-shell, which enjoys the scientific name of *Paphia* (*Ruditapes*) *philippinarum*. This shell is extremely abundant. Its empty shell is found all over the foreshore. These exhibit a great variety of colours and patterns. Another large bi-valve which is fairly common resembles in general shape the edible clam, but it may be distinguished by its very thin shell, which is of a pale mauve colour. Its name is *Mactra violacea*, and perfect specimens are very hard to secure, owing to the fragile nature of the shell. One of the very commonest of bi-valves to be found scattered over the foreshore is a beautiful purple form, *Sanguinolaria olivacea*, in which the valves are rather flat and oval shaped. In the fresh specimen the shell is covered with an olive brown integument, which gets rubbed



THE EDIBLE CLAM (*Cytherea zonorhiza*)

off in older specimens, revealing the beautiful colour—a deep purple—of the shell itself. Sometimes pink forms may be found, but these do not represent different species, but merely older and more faded specimens of *S. olivacea*. A very beautiful little bi-valve, which is also extremely abundant, is a species known as *Macoma praetexta*. In this species different varieties occur, some being white and some a beautiful shade of pink. They may be found scattered over the sand at low tide. Here also are found specimens of the razor-shell (*Solen brevis*), in which the valves are somewhat broader and shorter than in the well-known British forms. Razor-shells usually lie buried perpendicularly in the sand with the posterior end close to the surface to enable the valves to obtain free access to the water. Sometimes, when attacked by some predacious gastropod, they will

shoot out of the sand in order to escape their enemy. This operation has been witnessed at extreme low tide, and it accounts for the reason why perfect specimens with the animal inside may often be found lying about. As a matter of fact, in such cases they have only jumped out of the frying-pan into the fire, so to speak, since seagulls are ever on the lookout for them.

A shell that is not often found, owing to the animal's peculiar habits, is that of the piddock (*Pholas*). These creatures, when young, bore into certain suitable rocks by means of acid secretions, and there they live, gradually enlarging the cavity they inhabit as they grow. The mouth of the cavity, however, does not enlarge at the same rate as the rest of it, so that the shell is usually a prisoner. It is only occasionally that specimens get washed out from the rocks, when they may be picked up, upon the shore in a more or less broken condition. The valves are white and very brittle. A peculiarity about the piddock is that they have small additional valves, or dorsal shields, over the



THE CHINESE ARTEMIS (*Dosinia troscheli*)
(Reduced)

region of the hinge, or where the hinge should be. As a matter of fact, they have neither hinge, teeth nor ligaments, since the valves gaping at both ends renders it unnecessary for the animal to open them in order to obtain nourishment, as most other bi-valves do. Incidentally it may be mentioned that the animal is much too large for its shell.

Sometimes the visitor to the seaside may find certain very fragile and almost transparent shells of the order *Pelecypoda*. These are the valves of the so-called lantern-shell, of which a number of species are to be found along the China coasts. They, too, gape at both ends, and are related to the piddock.

The last order, *Septibranchiata*, need not concern us, since it contains but two families and very few species, none of which are to be found along the Chinese coast-line, all being members of the deep-sea fauna.

CHAPTER XXIII.

A CHINESE SEASHORE MISCELLANY

Besides the numerous well represented groups of marine animals which we have already discussed, there are a great many which are represented in these localities by but few species or the species of which are less well-known and need a considerable amount of investigation before much can be written about them. These are dealt with in the present chapter, which is the last of the series upon the animal life of the China coast line.

The visitor to the seaside will frequently be puzzled by the remarkable forms of animal life which he will find scattered along the foreshore and in rock pools. He will often be at a loss to know whether a particular form belongs to the animal or vegetable kingdom. An enormous variety of form is to be found, and indeed it should be realized that the members of this heterogeneous mass of animal life represents a far greater number of branches, containing innumerable species, than the great phylum *Vertebrata*, with which the average nature student is most familiar. That is to say, each of the following great branches of animal life is as diversified in its classes, orders, genera and species as the vertebrates, but, owing to the smaller size of the species and the fact that they live for the most part hidden from the casual observer in streams, ponds, the ocean, and underground, they are far less known to mankind at large, though none the less important to the zoologist. They are the modern survivals of the experimental products of Nature throughout the ages, some of them the primitive stages through which the higher branches of animal life have passed. They may be roughly classified and listed as follows :—

1. *Tunicata* or *Urochorda* : A class of animals which really belong to the vertebrates, but which are very simple in form. To it belong the sea-squirts, ascidians and the like, and they have some very remarkable characteristics.

2. The *Cephalocorda* : which includes small fish-like animals called lancelets or amphioxus.

3. *Echinodermata* : including the sea-urchins, starfishes, brittle stars, crinoids or lily-encrinites, and holothurians or sea-cucumbers.

4. *Brachiopoda* : including certain animals with valves somewhat resembling those of the bi-valve mollusks, and popularly known as lamp-shells.

5. *Bryozoa* : Animals closely related to the *Brachiopoda*, occurring in colonies like corals, and which are known as moss animals, sea-mats, and lace corals.

6. *Vermes* : An artificial division, which includes the host of worms.

8. *Porifera* : or sponges.

9. *Protozoa* : which includes the minute uni-cellular organisms such as the *Amœba*, *Foraminifera*, *Heliozoa* (sun-animacules) and *Infusoria*.



THE LANCELET (*Amphioxus*)

This is a long list and were we to attempt to deal with it adequately a whole volume would scarcely suffice. All its numerous representatives, except certain of the *Protozoa*, which belong to the Plankton, belong to the Benthos, which, it will be remembered, is the aggregate of animal and plant life that adheres to or crawls upon the bottom of the ocean.

The lancelets (*Cephalocorda*), which form a sub-phylum in the vertebrates, are amongst the lowest forms of animal life in which there is a spinal column. This is very primitive in form, being nothing more than a cartilaginous rod down the body. There are primitive gill arches, a circular mouth surrounded by cartilaginous filaments, while the body is lance-shaped. The eye is represented by a small pigmented spot on the anterior portion of the head. In life the body is almost transparent. The little creatures swim after the manner of fishes, and, indeed, look like some very primitive form of fish. They inhabit sandy bottoms and are able to burrow down into the sand at the least sign of danger. Scat-

tered throughout the world, they are very local in their occurrence. Species have been known from the Cornish coast, one or two places in the Mediterranean, on both shores of the Americas, and off Japan. Recently they have been discovered in the Amoy region, which fact gives them a place in the natural history of the China coast. They are far from common, however, and very little is known about them, so that the student of natural history would do well to look for them in suitable places in order that the species (whatever it is) may be adequately studied.

The tunicates get their name from the fact that the members of this branch are usually enclosed within a peculiar test or integument, like a jacket or tunic, from which fact the group gets its name, *Tunicata*. This tunic is very frequently composed of a cellulose substance similar to that of which the cell walls of plants are composed, and it is a remarkable fact that this is the only place in the animal kingdom where this substance occurs. The tunicates are also known as *Urochorda* from the fact that in the larval stage of their existence they have tails with a cartilaginous spinal column after the manner of a tadpole. The life history of a tunicate is very remarkable and merits description. As already stated, the larval stage closely resembles the tadpole stage in the common frog, the minute animal having a round body with a long tail, a mouth, gill slits, and a single eye. In this stage it is free swimming and very active. For a while it swims about in the water, finally coming to rest upon some suitable object such as a stone or rock surface, where it attaches itself by means of its mouth. There it remains growing firmly to the rock. The tail is absorbed, and as the creature grows it becomes more and more simple in structure until finally it is little more than a sack with a couple of openings and very degenerate structure. It is at this stage that it is known as a sea-squirt. There are a great many varieties of tunicates and numerous forms. They are not all attached to rocks, while a few, the *Larvacæa*, retain the tadpole form throughout life. Many occur in colonies, the colonies being produced by new individuals budding from the original stock. The tunicates are divided into two main classes, *Larvacæa* and *Acopa*.

As already indicated, the members of the former retain the free swimming, tailed form throughout life. The *Acopa* are again sub-divided into two main orders, the *Ascidicea*, or fixed forms, and *Thaliacea*, or free swimming forms. Of these the latter are

usually small creatures with the general shape of a barrel, and are found in the open sea, often occurring in chains. As they belong to the open sea they need not concern us here.

By far the majority of tunicates belong to the order *Ascidacea*, which is divided into two unnatural or artificial groups, *Ascidia simplices* and *Ascidia compositæ*, according to whether they occur singly or in colonies. True sea-squirts belong mainly to the genus *Ascidia* and are called ascideans. These are all attached to rocks, stones or sea-weed, and may or may not occur in colonies, the members of each colony not being attached to each other. They are more or less shapeless, dull-coloured creatures of little interest to nature lovers.

The members of the genus *Molgula* are usually more or less rounded with two short necks and star-shaped mouths. Very frequently the leathery coat is covered with sand particles, which renders the animal very inconspicuous.



Botryllus on a frond of seaweed

In the genus *Pyrosoma* large colonies of animals arranged in the form of a hollow cylinder swim freely in the open sea. They are very phosphorescent, from which fact the creature derives its popular name of fire-flame.

Perophora is a genus in which colonies grow in the form almost of a climbing plant, entwining themselves round branches of seaweed.

Amongst the most beautiful of the tunicates are those belonging to the genus *Botryllus*, which are in the form of small, gelatinous encrustations upon sea-weeds and rocks. In these a gelatinous mass is studded with what would almost appear to be rayed florets embedded within the mass. Each ray of these florets represents a single animal, and they develop by budding off from their parents. While examining seaweeds in the vicinity of Peitaiho I found several specimens of a species of *Botryllus* of a beautiful greenish colour. It is amongst these tunicates that the

most beautiful colours occur, some being mauve, others pink or red, and others green.

Our next great phylum is the *Echinodermata*, divided by zoologists into five classes :

1. *Asteroidea*, which includes all the various sea-stars and starfishes.

2. *Ophiuroidea*, including the brittle-stars.

3. *Echinoidea*, including the well-known sea-urchins.

4. *Holothuroidea*, including the so-called sea-cucumbers (beche-de-mer).

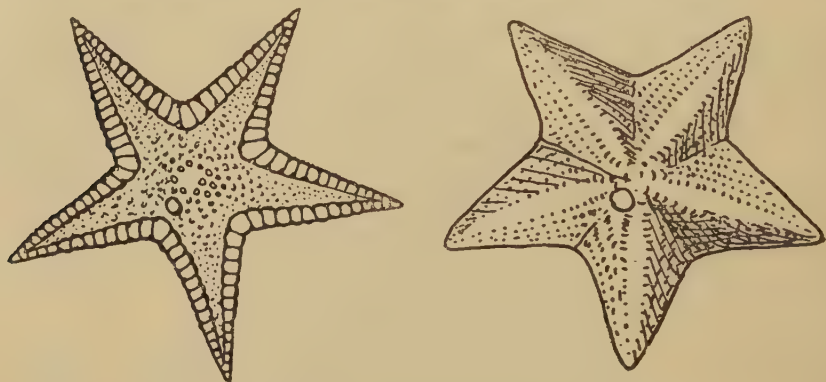


THE CHINESE SEA-STAR (*Asterias*)

5. *Crinoidea*, which includes the lily encrinites.

Of these the starfishes are too familiar to need any general description, though it may not be generally known that they have the power of creeping about over the sea bottom, and live upon other animals, such as mollusks and sea-urchins. If the student will examine the under surface of a starfish he will note numerous short tentacles which end in adhesive discs distributed along the middle of the arm. A more or less round cavity in the centre of the arms serves as the mouth. It is by means of the

tentacles that the starfish captures its prey, holding it in place while it egests its stomach from the mouth and envelops the wretched victim. Powerful digestive juices absorb the latter and when the meal is finished the starfish withdraws its stomach once more, and leaves the empty shell a significant relic of its horrid repast. The method of starfishes in attacking the spine-covered sea-urchin has been witnessed and described. The starfish repeatedly envelops its victim with its tentacles, withdrawing these and pulling off the spines. When the sea-urchin has thus been stripped of its protective spines the starfish digests it in the usual way. Along the China coast the commonest forms of sea-stars are a very large *Asterias* of a buff colour and spotted with purple; a flat, short-armed form, that is of a bright blue colour with orange-red spots

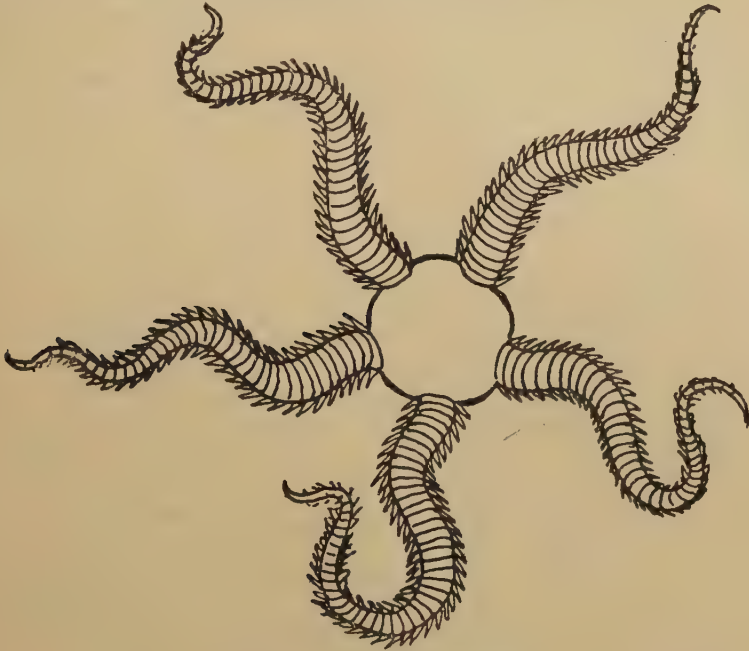


TWO SEA-STARS OF THE CHINA COAST

on the upper surface and bright orange below; and a small, grayish brown form of no very conspicuous appearance. As we pass southwards the species increase, and more beautiful forms are to be met with, but the majority of these apparently have not been identified.

The brittle-star resembles the starfish in having radiating arms, but differs, however, in that these arms are very much more mobile than the arms of the starfish, and can wriggle like a worm or serpent, hence the name of the class, *Ophiuroidea*, which means "serpent-tailed." The popular name is derived from the fact that the arms are very brittle and break off at the slightest touch, so that it is difficult to secure a perfect specimen. Several forms occur along the China coast. Amongst these is a rather large species of *Ophioglypha*, in which the central portion is disc-

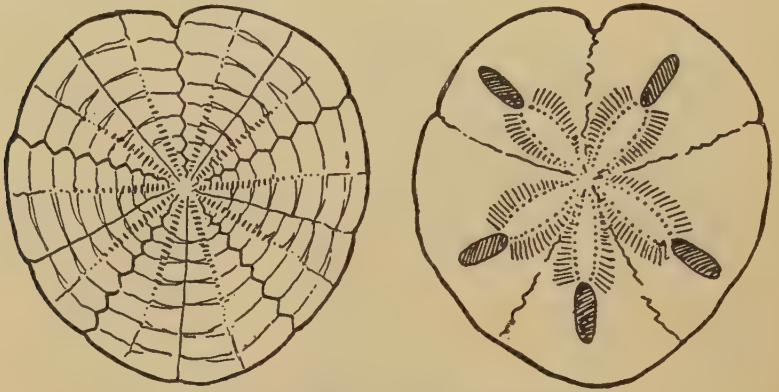
like while the arms are long and have the appearance of being scaled. Another form is much smaller and belongs to the genus *Ophiothrix*, which is characterized by the rather long arms being thickly edged with short spines, giving each arm a feathery appearance. The largest form of all has the tips of very long arms branched. This form may often be found entangled in sea-weed, all three being common only along the more southerly coasts and seldom, if ever, found in the northerly regions.



THE BRITTLE-STAR (*Ophiothrix*)

Sea urchins are another form of animal life met with on the sea-shore which need no introduction to the general reader. They are not very common in Chinese waters, though a few species occur. The reader will be more familiar with the skeletons of these animals, which are almost plum-pudding shaped, being hollow shells covered with small, roundish lumps arranged in rows, which radiate between holes at the top and bottom. In life the whole creature is covered with short (or, in some cases, long) spines, while fleshy tentacles may be extruded between these enabling the sea-urchin to draw itself about over rock surfaces, and helping it to capture its prey consisting of small crabs, etc., which it draws up

within its body. Another member of the *Echinoidea* is the so-called heart-urchin, in which the body is more elongate, the shell very much thinner and the spines finer. Members of this group are usually found buried in the sand and sometimes may be picked up on the shore after stormy weather. Their white, empty shells may be occasionally found but are so brittle and delicate that perfect specimens are very difficult to procure. Yet another form called the shield-urchin, and which is fairly common along the shore in South China, is extremely flat and almost disc-like. The reader may be familiar with examples of these forms in fossil collections in museums. Especially are sea-urchins common in the chalk formations of the British coasts, where very beautiful specimens may be found.



DORSAL AND VENTRAL ASPECTS OF A SHIELD-URCHIN WITH THE SPINES RUBBED OFF

The common sea-urchin of the China coast is known to science as *Luidia quinaria chinensis*.

Holothurians, or sea-cucumbers, are better known in China in native provision shops than as living creatures along the sea coast, though the observant student of nature may, at times, discover specimens amongst the rock pools. Popularly, but erroneously, known as the "sea slugs" of Chinese feasts, the holothurians form a very important item in the menus of Chinese dinners, though far from acceptable to the European palate. In shape they are elongate and certainly bear considerable resemblance to that of the cucumber. The bodies are gelatinous in some species, having calcareous spicules embedded within the flesh. Species in which the latter occur are, of course, useless as food. A great number of

different forms occur, especially along the southern coasts and in the tropical seas, where, as *beche-de-mer*, they form a regular item of trade. One interesting species is really remarkable for the fact that a small fish habitually lives within the body cavity, coming out occasionally to secure food.

In the crinoids the species mostly have a somewhat plant-like form, in many cases being rooted to some object at the bottom of the sea. Fossil remains of these are extremely abundant in certain rocks, and are known to the geologist as lily encrinites. A considerable variation occurs in their form of growth, some having long stalks with branches at the ends, others branches from the roots. The feather-stars are an example of the latter. A close examination of a crinoid will reveal that the main part of the body, where the organs occur, is placed in the centre of the flower-like portion at the end of the stalk. The rays of the flower, which are often branched, represent the arms in such echinoderms as star-fishes.

The lamp-shells (*Brachiopoda*) represent a very old order of animals, having been extremely abundant in the ocean as long ago as Cambrian times. It has been estimated that there are something like six thousand fossil species, while of forms represented in the ocean to-day there are not more than one hundred and fifty. At one time brachiopods were far more numerous than mollusks, but this state of affairs has long since been changed. In their general outward appearance the lamp-shells resemble bi-valve mollusks, but they differ in some very fundamental points; for instance, in a bi-valve mollusk the valves are situated to the right and left of the body, and are usually symmetrical; in a lamp-shell they are situated above and below the body of the animal, and are also different. There are two main divisions in the phylum, viz.

1. The Ecardines or *Inarticulata*.
2. The Testicardines or *Articulata*.

The ecardines are characterized by the absence both of hinges to the shell and an internal skeleton, while the testicardines have the valves hinged after the manner of the bi-valve mollusks, and possess an internal skeletal structure. The chief representative of the former is the well-known *Lingula*, in which the valves are in the shape of a duck's bill, are more or less horny in structure, and may be of a golden, brown or bright emerald green colour. In these peculiar animals there is a long, fleshy

stalk, which bores down into the sand, where the animal lives in a burrow. When not disturbed the valved portion of the animal comes to the surface of the sand, where a slit-shaped opening to the sea occurs. At the slightest sign of danger the long stalk contracts and draws the animal deep into the sand, well out of danger. In rough weather, when the sandy bottoms are more or less disturbed, the valved portion of the lingula may be broken from the stalk and washed ashore, where the student of nature may find it. An examination of the internal structure will reveal two mantles within the valves, a small, oblong body, and two peculiar coiled arms, which are fringed with filaments. In life, and when the animal is undisturbed, these filaments protrude between the valves like a fringe round the animal, and keep up currents of water which supply oxygen and food to the animal. I have found, on different occasions, two species of lingula along the Chinese coast, namely, *Lingula anatina* and *L. murphiana*. Of these the former is a small, bright green form, while the latter



THE LINGULA (*Lingula murphiana*)

is large and of a horny, yellow colour. Lingulas belong to the order *Atremata*, of which the *Lingulidæ* is the only family. It is a very interesting fact that *Lingula anatina* affords an interesting example of the persistence of a single species almost unchanged throughout countless ages of the earth's history, fossil remains of this form occurring in rocks of the Cambrian Epoch.

The second order in the *Inarticulata* is *Neotremata*, and it includes certain peculiar forms which adhere to rocks, almost like oysters, and in which the valves are more or less disc-like. I secured a single specimen of the species of *Discinisca stella* belonging to the family *Discinidæ*. The only other family in the order is *Craniidæ*, in which the shells appear almost as limpets upon the surfaces of the rocks.

It is from the members of the class testicardines or *Articulata* that the name "lamp-shell" is derived, for in

these the lower valve is shaped very much after the manner of the clay lamps used by the ancient Romans; that is to say, in the form of a somewhat flattened bowl with a spout and hole at one end. In life a stalk passes from the animal through this hole and attaches it to the rock surfaces. The upper valve is smaller than the lower, and opens and shuts upon it in the form of a lid. An examination of one of these shells will reveal a peculiar skeletal framework within, upon which the fleshy tissues are supported. Here again will be found peculiar coiled arms with filamentous fringes, which closely resemble in appearance the gills of a fish. The class is divided into two orders, *Protremata* and *Telotremata*, the former being represented by but a single family, *Thecidiidæ* which is almost extinct, and in which the lower valve adheres to the rock by its convex surface and not by means of a peduncle, and the latter by three families, *Rhynchonellidæ*, *Terebratulidæ* and *Terebratellidæ*. No members of these families are common, and comparatively few species have been discovered off the China coast; in fact, these animals are mostly denizens of the deeper parts of the ocean and so do not really concern us here.

It is impossible even to commence to deal adequately with the *Bryozoa*, since their name is legion and their form multitudinous. Roughly speaking, they may be described as colonies of small animals contained in variously shaped shells, the shells growing sometimes in the form of branched sprays, sometimes as encrustations upon rocks, sea-weed fronds and the shells of mollusks, sometimes as broad-bladed fronds very similar to sea-weeds. Each animal is contained within a sort of box-like cell, and consists of a very simple body with alimentary canal opening to the surface at both ends, the anterior of which is fringed with tentacles which serve the purpose of gills. The animal can be withdrawn inside the cell or extruded. In some cases a small door or operculum occurs, in others the opening remains always in contact with the exterior. In the lace-shells, as certain of the *Bryozoa* are called, the cells are composed of a very hard substance and are so arranged that the whole colony closely resembles a piece of coral in appearance. In the sea-mats the cells are arranged in the form of a flat lobed frond, not unlike the frond of such a sea-weed as the common *Fucus* or wrack. A good many different forms of *Bryozoa* occur on the China coasts, and these may be distinguished from other lowly

forms of animal life that they closely resemble by a careful examination of their structure under a magnifying glass.

Crisia eburnea and *Aetea anguinea* are two very common forms of the China coast, often found in close association, while a seamat (*Membranipora*) is also extremely common.

The great group *Vermes*, or worms, to which in times gone by have been relegated innumerable forms of animal life that puzzled zoologists, has now been split up into numerous phyla, since it has been realized that many of them are not really related to one another.

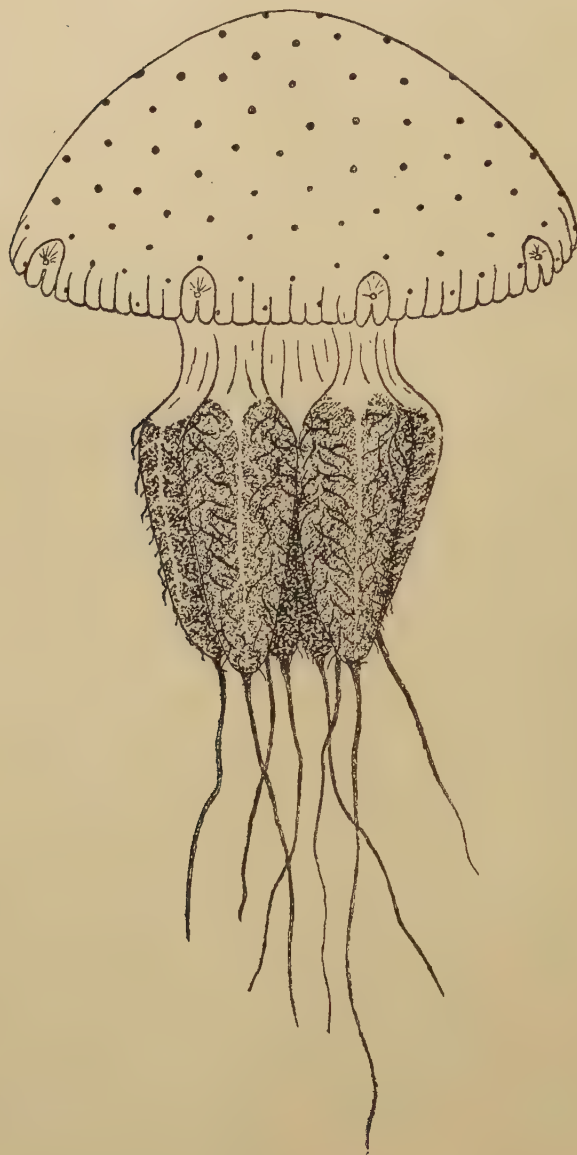
These are :—

1. *Platyhelminthes*, which simply means flat worms, to which belong the members of the class *Turbellaria*, free swimming forms inhabiting the sea or fresh water, and those of the class *Trematoda*, including the liver-flukes and blood-flukes, tape-worms, etc.
2. *Nemertinea*, which are marine worms living under stones and amongst sea-weed.
3. *Rotifera*, which includes numerous very small aquatic animals, but few of which, however, are found in the sea, mostly occurring in fresh water.
4. *Nemotoda*, which includes the thread-worms, mainly parasitic in other animals.
5. *Annelida*, worms in which the body is in the form of successive rings (hence the name), and to which phylum belong the earth worms and so-called polychaet worms, which abound on the floor of the ocean. The leeches also belong to this phylum, but they are mostly fresh-water species. To the order *Polychæta* belong all the various worms which fishermen use for bait, and they are too numerous to describe in detail. Many of them are free moving animals to be found either in the sand, under rocks, or crawling about amongst the weeds; others however make for themselves cylindrical chambers of various substances in which they live. The free moving forms are variously known to fishermen in England as different kinds of "lug" worm.

Most of my readers will be very familiar with jelly-fishes and sea-anemones, both belonging to the *Coelenterata*, which means animals with a body cavity. Jelly-fishes, such as are seen floating in the ocean during the summer months, represent one

phase of the life of a typical coelenterate—the medusa phase, while the sea-anemone represents what is known as the polyp, or hydra, phase. A typical jelly-fish in its youth is in the form of a club-shaped mass of jelly, the thin end of which is anchored to the sand. As maturity approaches this breaks off, section by section, from the thick end, each section floating away as a young jelly-fish and then growing in size till it attains the dimensions of the enormous and beautiful creatures which we see floating about on a warm summer's day. Most of the members of the group are armed with peculiar little cells containing a sort of poisoned dart or harpoon, which is shot out from the cell on contact with some foreign body. They are thus able to sting, and, in the case of such animals as the sea-anemone, paralyze their prey, which they subsequently draw with their tentacles within the body cavity. To this order belong the corals, the animals of which are very small compared with the sea-anemone, which they closely resemble. They occur in large colonies, building round themselves calcareous structures. It is these structures that constitute the beautiful forms called corals. A superficial examination of a typical coral will remind one very much of a colony of *Bryozoa*, but a more careful examination will reveal the difference. As in the *Bryozoa*, so amongst the *Coelenterata* there is a great variety of form. Three or four common species of jelly-fish are to be found on the China coast, and some of these are used as food by the Chinese. The jelly-fish is caught when it is at its maximum size in the summer, and by treating with brine is reduced to a somewhat tough substance which finds a sale in the Chinese markets under the name of "sea stomach", and is considered a great delicacy at Chinese feasts. Recently a new species, *Acromitus tankahkeei*, has been described from the Amoy region by Prof. S. F. Light.* It is an interesting fact that a minute fresh-water jelly-fish has been discovered inhabiting the Yangtze River. It is related to others that occasionally make their appearance in water lily tanks in hothouses in Europe, and the origin of which has never been explained, though it is believed that they have been brought in the polyp form adhering to the stalk or roots of such lilies as the *Victoria Regia* from South America. A form of fresh-water jelly-fish has also been discovered in Africa.

* *The China Journal of Science and Arts*, Vol. II, No. 5. Sept., 1924. pp. 449-450, Plate.



THE NEW CHINESE JELLY-FISH (*Acromitus tankahkeei*, Light), described
by Professor Light from the South China seas.
From a drawing by H. W. Wu.

Sea-anemones are usually to be found amongst the rocks, where they attach themselves by their bases, frequently within the cranies. When undisturbed they extend their bodies and spread out their beautiful tentacles, which are often brilliantly coloured. At such times they very much resemble some beautiful blossom; hence their name. These tentacles are in a certain manner adhesive, and any intruder in the form of a crab or other marine animal that may come within their reach is grasped and drawn into the animal's stomach.

In the phylum *Porifera*, or sponges, a more or less gelatinous mass composed of variously formed cells, and drilled through and through with chamber-like galleries, is supported by a tangle of horny fibres or siliceous (glassy) spicules. At the ends of the galleries or canals are chambers, the surfaces of which are lined with ciliated cells. It may be noted that some of the galleries are much narrower than others but all, sooner or later, communicate with the exterior. The mouths of the narrow canals are known as pore, while the mouths of the wider galleries are known as oscules. The cilia, or flagellæ, of the surface cells of the chambers, by means of their rapid motion, drive water along the broad canals, which is ultimately expelled with considerable force at the surface of the sponge. To replace this, fresh water containing minute sea animals and plants (diatoms) and dissolved oxygen is drawn into the body of the sponge by way of the narrow canals, thus bringing about the processes of feeding and respiration. The living cells of different parts of the sponge are differently named, and it is not quite clear whether the sponge represents a single living organism, with differentiated tissues, or a colony of differentiated individual cells. Sponges occur in a variety of shapes such as round masses, long clubs, cups, etc., and they are to be found adhering to rocks, weeds, shells, or any other suitable surface at the bottom of the sea. Only a few small forms are to be found close inshore, the larger species used in our households being gathered in more or less deep water in tropical regions. In the beautiful glass sponges, of which the well-known Venus' flower basket (*Euplectella*) and the Japanese glass-rope sponge (*Hyalonema*) are examples, the supporting skeleton is siliceous, and when dissected out is found to be formed of a great variety of peculiarly shaped spicules, some in the form of dumb-bells, some like anchors, some like harpoons, some like lances, and so on. Some

of these beautiful forms are to be found off the coasts of South China, but, in the main, the group *Porifera* is poorly represented in our regions. While on this subject mention should be made of the fresh-water sponges, many species of which have been described by the late Dr. Annandale, while papers have recently appeared upon the subject by Mr. N. Gist Gee, of the China Medical Board, in *The China Journal of Science and Arts*. These fresh-water sponges are usually in the form of soft brownish incrustations on rocks or stones on the bottoms or sides of streams, lakes or ponds.

The *Protozoa* represent the most primitive forms of animal life, namely the innumerable host of unicellular forms typified by such creatures as the amœba, the bell-animalcules (*Vorticella*) and globigerina. The sea contains an enormous number and variety of these minute animals, indeed, an examination of the ooze at the bottom of the ocean reveals the fact that it is composed to a considerable extent of the dead remains of these minute forms, together, it must be admitted, with their counterparts in the plant world, the diatoms. Here lies a great field for study, and the student of animal life, who wishes for pleasant occupation while visiting the seashore, cannot do better than take with him a microscope and examine the water for these minute forms. They show a considerable variety of form in spite of the fact that they are unicellular. The simplest is the amœba, which is nothing but a small blob of protoplasm with the power of extruding portions of itself in all directions, and which proceeds by flowing, as it were, over some supporting surface. When it meets particles of food it merely flows round them, digests them, and flows on, leaving the remains behind. Reproduction is brought about by simple fission; a single cell dividing into two equal parts and each part growing until a maximum size is reached, and then repeating the process. The members of the *Foraminifera* are supplied with a minute shell of calcareous matter, and it is these that in by-gone times have helped to build up our limestone and chalks of the Carboniferous Age, the ocean at that time evidently being favourable to that form of life. To the foraminifers belong the globigerina, the orbitolites, and other very beautiful forms. Their shell remains may be found by examining shell beaches very closely.

Other members of the *Protozoa* are the sun-animalcules (order *Heliozoa*), but these are inhabitants of the fresh water.

In the order *Radiolaria*, which includes the lattice-animal-

cules, the members have sphere-like skeletons, very much like the beautiful carved ivory balls that are made in Canton and Ningpo, in some forms one perforated ball occurring within another, while variously shaped rays stand out from the surface of the outer one. In life, protoplasm extrudes through the orifices into the surrounding medium, water.

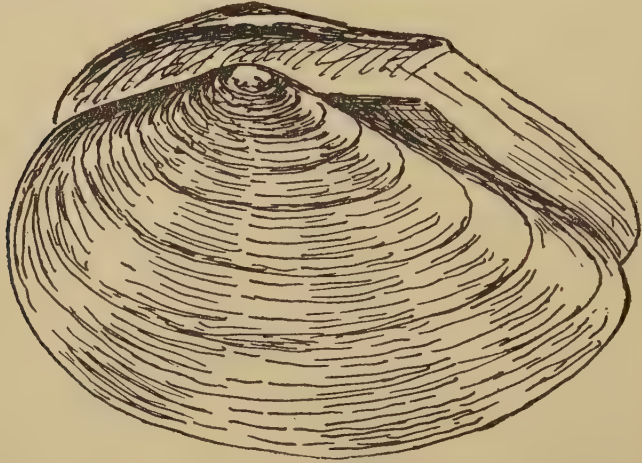
Finally we have the *Infusoria*, to which belong the little phosphorescent animalcule *Noctiluca*, which is responsible for the phosphorescence of the ocean. The bell-animalcules already mentioned belong to a separate order known as *Ciliata*. These should be looked for on the stalks of weeds and in the brown scum that may be scraped off rocks, but nothing short of a microscope will reveal them to the student.

CHAPTER XXIV.

THE LAND AND FRESH-WATER MOLLUSKS OF CHINA.

In a previous chapter the marine mollusks of the Chinese and inshore waters have been dealt with. We may now consider for a while the land and fresh-water mollusks, most of which would be considered by the general reader as snails of some sort or other.

As a matter of fact all the land inhabiting mollusks, excepting the slugs, are snails, while of fresh-water mollusks the only



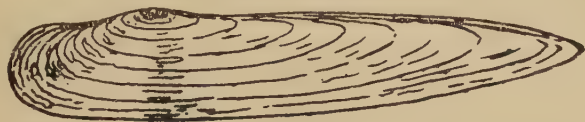
THE CHINESE SWAN MUSSEL (*Anodonta woodiana*)

forms that are not snails are the various species of mussel and their relatives, which belong, of course, to the great class *Pelecypoda*, or bivalves, the order *Eulamellibranchiata*, and the family *Unionidæ*.

Chinese rivers and streams are the homes of some very beautiful species of mussel, of which a very large species is found throughout all the waters of the low-lying plains. This is a form of *Unio*, not unlike the British painter's mussel (*U. pictorum*). In the rivers and streams of the south occurs the well-known

pearl mussel (*Margaritina margaritifera*), from which are obtained the Chinese pearls. The species should not be confused with the pearl oyster (*Margaritifera margaritifera*) of the India Ocean.

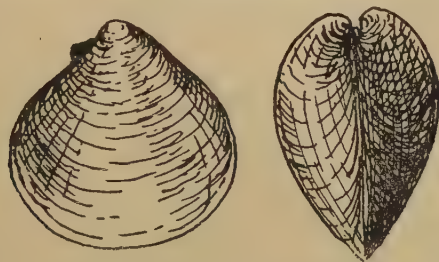
The Chinese take advantage of the pearl mussel's habit of covering extraneous substances that get between the folds of the mantle and the valves of the shell with a coating of pearly substance by introducing little figures of Buddha, which, after a while, are taken out covered with nacre, and thus look like



THE KNIFE MUSSEL

pearls in the form of the deity in question, when they are used as head ornaments.

The swan-mussels (*Anodonta*) are well represented in Chinese rivers, streams and canals. In the numerous members of this genus the hinges are toothless in contrast with those of the genus *Unio*. A considerable variety of form is displayed in these fresh-water mussels, in some the valves being long and narrow, like knife-blades in shape, in others almost plate-



THE BASKET MUSSEL (*Corbicula fluminalis*)

like; in some thick and heavy, in others thin and rather fragile; in some deep, in others shallow. Some attain a considerable size.

A very common fresh-water bivalve is a species with the scientific name *Corbicula fluminalis*. It is more rounded than the mussels. The valves are heavily grooved in concentric rings, and, though of a violet or purplish colour, are covered with an olive greenish-brown integument. The Chinese are very fond of this species as food.

To return to the mollusks that may legitimately be called

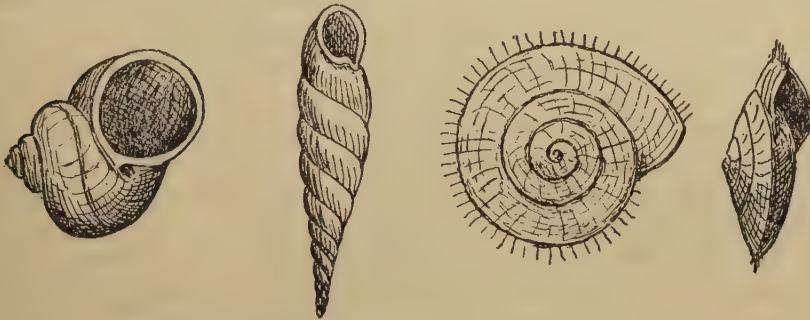
snails: we may first deal with those that inhabit the land. It must be made clear from the outset that the subject of the terrestrial mollusks of China is comparatively little known. Although a good deal of work has been done in the way of collecting and classifying the species, it is certain that a great many remain to be discovered, not only amongst the larger and more obvious species, but especially amongst the minute forms that usually escape the unaided vision of the field naturalist. The name of the latter is Legion, and they are only to be examined properly by means of a powerful magnifying glass. In countries bordering China, a great many species have been found and described, but in China, it is mainly the larger, and more conspicuous forms that are known.

It is impossible to give accounts of all, or even a small proportion of these. A few only can be specially mentioned.

Before going into details of the various groups of terrestrial and fresh-water snails, it might be as well to note a few points which they hold in common. One point is that they all have much thinner and lighter shells than the marine snails, while they are also as a rule much smaller. This is easily explained. In the first place the marine snails, especially those that occur along the coast line, have to put up with the buffeting of the waves, while the land snails live in the peace and quiet of coppice and wood. Then, the marine mollusks are faced with the necessity of protecting themselves against all kinds of voracious fish with powerful jaws. The land and fresh-water snails protect themselves by hiding in brush or weeds. Besides, they would not be able to support the heavy weight of shell carried by their marine relations, since this would be much heavier in the medium of the air than it is in the more buoyant water. Thus we see the snail adapting herself to her surroundings. It is interesting to note that all land and fresh-water snails had their origin in the sea, and even to-day we have examples of species that are in the process of changing elements. By far the greater number belong to the family *Helicidae* of the order *Pulmonata*, (univalve mollusks that breathe by means of an air-cavity instead of gills). The helioid snails are further distinguished by the fact that their eyes are placed at the ends of their retractile tentacles, differing in this from the pond snails, in which the eyes are situated at the bases of the tentacles.

Some slugs also belong to the family *Heilicidæ*, though mostly the land slugs are placed in the family *Limacidæ*. Slugs, however, are by no means common in China, at least in the northern and central provinces, and so may be dismissed without further notice here.

In the northern provinces, which are inclined to aridity, land snails are comparatively rare, only one or two species being at all common. The commonest is a small, somewhat flat-shelled species of *Helix* that is also to be found rather abundantly as a sub-fossil in the loess deposits of Shansi, North Chihli, Shensi, Kansu and Honan. It is found abundantly in a living state in certain areas, being especially numerous in and round Peking. It is of a whitish colour with a dark brown band follow-



A. THE CHINESE ROUND-MOUTHED SNAIL
 B. THE CHINESE *Clausilia*, or Door-shell
 C. A CHINESE LAPIDARY SNAIL (Top and Side Views)
 (All enlarged)

ing the direction of the spiral. It seldom attains a diameter of more than half an inch.

Another common species in the north is a plain, brownish, thin-shelled form of about the shape (though smaller) of the British common garden snail (*Helix aspersa*). It is a variety or subspecies of *Eulota ravidæ*. In the lower Yangtze Valley a closely related form, which attains a large size, fully as large as the English garden snail, is very abundant. This form has a thin shell of a pale horn or yellow colour.

In mountainous regions in the north the writer has found specimens of lapidary snails (*Trochomorpha*), which are very flattened and have the outer margins of whorls keeled. They

usually occur clinging to the surfaces of rocky cliffs. In the Min Valley in Szechuan, Mrs. E. W. Mead, wife of the British Consul, discovered a new species of lapidary snail which was called *Trochomorpha lancasteri*. Another new helicid snail discovered by the same lady is *Trichocathaica lyonsæ*.

As we pass southward the number and variety of land-snails increase. In Central China they have become comparatively numerous. A large, banded species of *Helix* is abundant in certain parts of the country. In the Nanking district the writer has found some half-dozen or so species of snail, including a lapidary snail, very different from the North China form, several different kinds of banded snails, as well as a *Pupa* and a *Clausilia*, or door-shell, as it is popularly called.

But it is when we come to South-eastern and Southern China that land snails begin to get really plentiful, and the writer has collected a number of species in the province of Fukien, the names of which are as yet unknown to him. Here we find members of other families than the *Helicidæ* plentiful. For instance, the family *Pupidæ* is well represented. The members of this family have the shell more or less spindle-shaped, often closely resembling the pupae of moths, hence the name.

In Foochow a species of *Clausilia* is very common, while specimens of species of *Pupa* are prevalent. One of these, which is very common in places, when in an immature stage resembles exactly the blunt spines or protuberances on a *Ficus* vine, which it inhabits. The adult is to be found clinging to the under surfaces of large leaves.

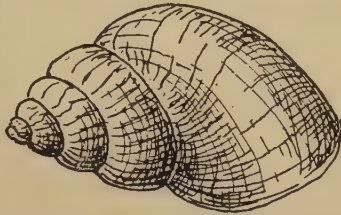
In Fukien may also be found a large, rather flat snail, of a fine brown colour, while in the Hangchow district another very large species, with a diameter exceeding that of a dollar piece, is prevalent.

The members of the order *Pulmonata*, to which all the foregoing belong, are characterized by having the sexes united in each individual, thus being hermaphrodite. Both sexes function at once. In one group certain little organs called "love-darts" are present. These are discharged from one individual into the other during the process of mating, it is believed to cause sexual excitement.

Before leaving the land snails for those that inhabit fresh-water, mention should be made of a species of round-mouthed snail, somewhat resembling, but considerably larger than, the

British round-mouthed snail (*Cyclostoma elegans*). It happens that these species belong to an altogether different group of univalve mollusks, to wit, the *Prosobranchiata*, in which breathing is performed by means of gills, most of the species belonging to it being marine. The round-mouthed snails are close relations of the periwinkles, and like them have a little lid, or operculum, which fits the mouth of the shell when the animal withdraws itself. This effectually retains the moisture inside, and prevents the animal from drying up in dry weather. The round-mouthed snails are believed to have left the sea, or at any rate an aquatic life, comparatively recently; their near relations the periwinkles may be said to be in the act of leaving the sea for the land. The members of the family *Cyclostomatiidae* are, therefore, very interesting in their way.

Not far removed from them are certain aquatic snails, such as the river snails (*Vivipera*), the spire-shells (*Rissoa*) and the



A CHINESE RIVER SNAIL, *Vivipara quadrata*. (Reduced)

bythinias (*Bythinia*), of which *Vivipera* and *Bythinia* are certainly represented in Chinese waters.

These must not be confused with the pond snails and their relations, which belong to the same order as the majority of land snails, *Pulmonata*.

They may be dealt with first. The river-snails are members of the order *Prosobranchiata*, that is to say, like the majority of marine "snails," or univalves, they breathe by means of gills. They have tentacles and eyes, with a distinct proboscis and well developed mouth. They also have doors, or opercula, to the mouths of their shells. An interesting point about them is that the young are born alive, and not hatched from eggs, as with the pond and land snails. Hence their generic name. There are numerous species in China, the common form round Shanghai being *V. quadrata*. Specimens secured by me in Fukien have

been referred to the species *V. lecythoides*. In these species the shell is strongly spiral, the spire being not very drawn out, while dark bands follow the direction of the whorls. The bythinias are much smaller and have longer, more drawn out spires. Amongst other species *Bythinia spiralis* and *B. subangulata* may be mentioned as of common occurrence in the mountain streams of South-east China. In these the shell of the former is smooth, banded dark, that of the latter ribbed.

The so-called pond snails (*Limnæa*) and their relations the stream snails (*Melania*) and the ram's-horn, or trumpet snails (*Planorbis*) being pulmonates, that is, breathing by means of air-cavities, belong to the same order as the land snails, from which they differ, as already mentioned, in having their eyes situated at the bases of tentacles instead of at their extremities. They have to breathe by direct contact with the air, and, if they could not get to the surface of the ponds in which they mostly live, would soon drown. In this they differ markedly from the river snails.

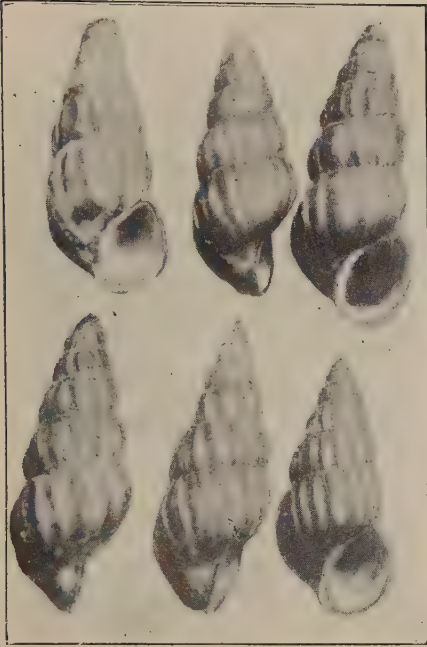


A CHINESE SPECIES OF CHRYSLIS
SNAIL (*Pupa*)



A CHINESE POND-SNAIL (*Limnæa*
acuminata). (Enlarged)

The members of this group (*Basommatophora*, as the sub-order is called) are probably the most interesting of all snails to the human race, owing to the fact that certain species form the intermediate hosts of certain parasitical worms, or flukes, that attack man or his domestic animals, causing serious diseases. Thus the liver-fluke (*Distoma hepatica*) which attacks sheep in Great Britain, spends one of the phases of its life-cycle in the dwarfed pond snail (*Limnæa truncatula*), while in China and Japan a stage of the Oriental blood-fluke (*Schistosoma japonica*)



Oncamelania schmackeri, the
intermediate host of the
bloodfluke, *Schistosoma*
japonica. This is a small
water-snail belonging to the
pond-snail group
(Magnified five times)

Photo by E. C. Faust



A FOSSIL BEETLE (*Proteroscarabæus yeni*), found in the Lower
Cretaceous Rocks of Shantung

is spent in a minute pond snail known to science as *Oncomelania schmackeri*, which is extremely abundant in certain waters in the Yangtze Valley. A small species of *Planorbis* is the intermediate host of a large intestinal fluke. Medical men in China are concentrating on a study of these flukes and snails, and we may soon expect to hear of further interesting and important discoveries.

The members of the genus *Limnæa* may be recognized by their thin shells, in which the body whorl is usually very large and the spire correspondingly small, though pointed. They may frequently be seen floating foot upwards on the surfaces of ponds. The commonest species in these parts is *Limnæa acuminata*. Further north *L. pervia* is prevalent. *L. ollula* is a small species common in the Lower Yangtze region.

Melania and *Oncomelania* bear some external resemblance to *Bythinia*, but have the shells roughened by cross-grooves on the whorls. *Melania ningpoensis* is prevalent round Shanghai and the Yangtze Delta, while *M. terminalis* takes its place further south. As already stated *Oncomelania schmackeri* is prevalent in the Yangtze Valley, though it may be mentioned that the naturalist Heude, whose fine collections lie in the Zikawei Museum, described a number of species from these parts.

Finally we may mention a species of thin-shelled snail that might be called amphibious, since it is always to be found in the vicinity of fresh water, though usually not in it. This is the little amber snail (*Succinea chinensis*) which looks somewhat like a pond snail (*Limnæa*) but belongs to the same sub-order as the land snails in that it has the eyes at the tips of its tentacles. Its shell is transparent, very delicate, and of a clear amber colour. The animal is blackish. Far from common, I have found this lovely little snail in two places only. These were on some rocks down which a spring trickled at Pei-tai Ho, the popular summer resort in North China, and in the Shanghai district. It may be of interest to the reader to know that the amber snail forms the intermediate host of a fluke that infects birds.

This account by no means exhausts the subject of land and fresh-water snails of China, but it may help the reader to gain some idea of a subject which is very little known, and in which a vast amount of work remains to be done.

CHAPTER XXV.

SCORPIONS, SPIDERS, CENTIPEDES AND THEIR RELATIONS.

Though to most people scorpions, spiders, ticks, centipedes, and numerous other objectionable looking creatures are included in the term "insect," this is not the case with the systematic naturalist, who has decreed that an insect is an animal belonging to the great phylum *Arthropoda* (jointed-legged) which has, in the adult stage only six legs, three on each side. At least, that is the surest and easiest way of distinguishing a true insect.

Spiders, scorpions and ticks, have eight legs, four on each side, while centipedes and their relations have a great many more, as the name suggests. Thus, technically, these creatures are not insects, but the layman need not worry about such precise distinctions, knowing, as he does, that if he refers to a scorpion or a spider as a "nasty insect" he will be perfectly understood, even by the zoologist, though he may have to submit to being corrected by the latter.

The living arthropods are divided up into four classes, which for the sake of definiteness may be listed as follows :—

Crustacea : crabs, lobsters, shrimps, etc.

Arachnida : scorpions, spiders, ticks and mites.

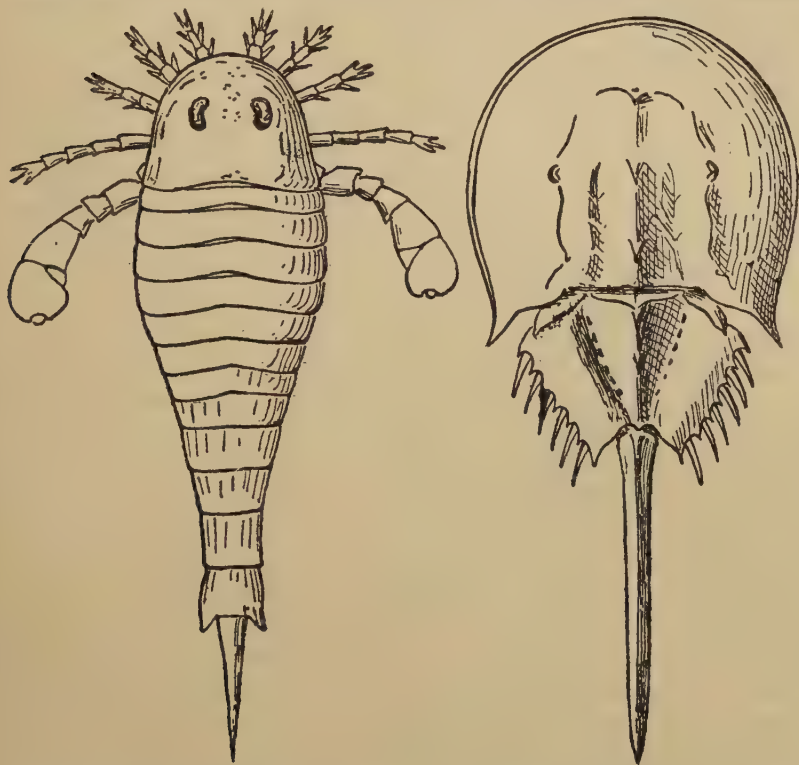
Myriapoda : centipedes, millipedes, pill-millipedes, etc.

Insecta : moths, flies, beetles, bees, grasshoppers, etc.

We are not concerned here with the first or the last of these, as they are dealt with elsewhere in this book. This chapter is concerned with the two middle groups. Of these let us take first the arachnids, of which the chief distinguishing feature is the presence of eight legs. It may be argued that a crab also has eight legs, and that therefore this simple means of distinguishing between the arachnids and crustaceans is unsound. Closer observation will reveal the fact that, hidden under the "tail" which is tucked up under the body of the crab, are several more appendages, which, if not exactly legs, are nevertheless something which the spiders and ticks lack. They are swimmerets, and all crustaceans have

these in addition to their walking appendages or legs, while the arachnids have only their legs, and one or two extra pairs of appendages situated anteriorly to the legs, which are used for various functions.

Another feature distinguishes the arachnids from all other arthropods, and that is their complete lack of antennæ.



Eurypterus, the Pre-historic marine ancestor of the present day King Crabs and Scorpions THE CHINESE KING CRAB (*Xiphosura longispina*) from Fukien. (Greatly reduced)

Crustaceans, myriopods (centipedes etc.) and true insects all have jointed antennæ protruding from their heads, the spiders, scorpions, ticks and mites have not.

This brings us to the interesting fact that the so-called king-crab (*Xiphosura* or *Limulus*) is not a crab (*i.e.* a crustacean) at all but an arachnid; and before we go on to discuss the other members of this class, it would be well to stop and consider this remarkable inhabitant of the sea.

The history of the rocks tells us that long, long ago, before there were any terrestrial arthropods, the sea was infested with large creatures, called by palaeontologists *Eurypterus*, *Pterygotus*, and *Stylonurus*, etc., which were remarkably like gigantic scorpions. It is interesting to note, by the way, that a fossil eurypterid has recently been discovered in Permian rocks in China, revealing the fact that in that long gone epoch China lay under the ocean. It has been called *Eurypterus chinensis* by Dr. A. W. Grabau, of the Geological Survey of China, and it is very like the well-known *E. fischeri* of European Silurian rocks.

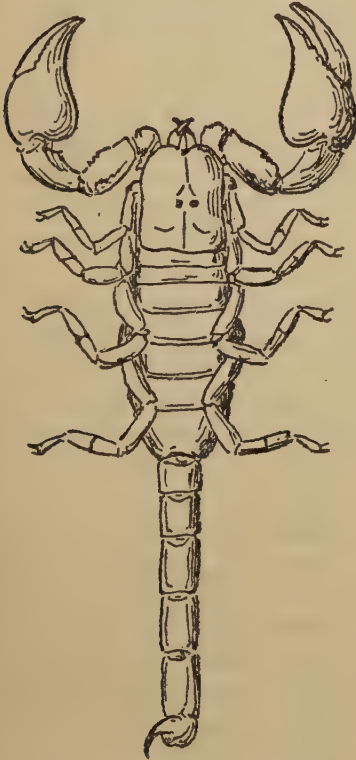
The eurypterids were indeed the ancestors of both the present day king-crabs and the present day scorpions, the former representing their descendants who kept to the floor of the ocean, and the latter those that left the sea for the land. Thus the king-crab, of which the Chinese species is known as *Xiphosura longispina*, forms an interesting link between the dry land scorpions (and through them the spiders and mites, which appear to be a further, or at least a parallel development from the same source) of the present day and the great sea scorpions, as the eurypterids may be called, of Silurian, Devonian and Permian epochs.

The king-crab keeps to the sandy bottom of the sea, where it feeds upon worms and mollusks, which it captures by means of its pincer-tipped legs. In it the segments of the body have become fused together to form a shield-like carapace, contrary to what happened in the case of the scorpions. There is a long pointed spine-like tail, articulating with the second body shield. In the male the anterior pincer-legs are greatly thickened and sub-chelate, while the anterior rim of the carapace is indented. This species is very common off the Fukien coasts, and in early summer swarms over the shallow tidal flats, where it apparently breeds. It is taken in great numbers and sold for food in the fish-markets.

The scorpions have all greatly diminished in size from their gigantic eurypterid ancestors, some of which were several feet in length. Mere inches now take the place of feet, which is fortunate, considering the scorpion's vicious disposition and terrible means of offence and defence. In China there are a number of species of scorpion. In the north, as far north as Peking and beyond, which is the most northerly range of the group, one species, *Buthus martensi*, is very common, occurring in old

buildings under stones or in cracks in the walls. This species attains a size of not more than $2\frac{1}{2}$ inches. Its sting is very bad, but not fatal.

In South China a much larger species occurs, and it is said that its sting is often fatal. It is closely related to the Indian



THE SOUTH CHINA SCORPION



THE WHIP-SCORPION :
found in South-east and South China

(Natural Size)

species, *Scorpio swammerdami*, but is somewhat more slender. An interesting point about scorpions is that they are viviparous, the young being like the parent at birth.

Related to the scorpions are the whip-scorpions, (*Thelyphonus*) a species of which is found in south-eastern China. This terrifying looking creature has, like the scorpion, two powerful

grasping appendages in front, while its legs are longer than those of the scorpion. Its abdomen instead of being long and slender is wide, and ends in a long whip-like lash, hence the name. The whip-scorpion excavates for itself a commodious chamber in the earth under some rock, access to which is by a neat round hole that looks like the burrow of a field mouse. There the sinister creature lies up during the day, coming out at night to catch its prey, insects, worms and the like. The whip-scorpions, belong to the order *Pedipalpi*.

A step further, and we have the spiders, order *Araneæ* in which the abdomen is not segmented, there are no grasping appendages, their place being taken by palps, while the jaws are armed with poisonous claws. Spiders also have the power of spinning webs, a complicated arrangement for this purpose being present in the fat abdomen.

There are a great many different species of spider in China, by far the majority of which have not as yet been named or classified.* This is strange considering what interesting creatures spiders are. Their habits always repay observation. Particularly interesting are their mating habits, the male usually getting the worst of it, and falling a victim to the lady spider's ill nature and voracity. In many species he has to approach the lady of his fancy with great care, displaying his attractions, whatever they be, in the hopes of winning her favour. To be eaten is the penalty of failing to make good his suit. To be eaten is often the reward of success. But what matter, he has done his part.

The wolf-spiders (*Lycosidæ*) do not build a web, living on the ground, and pursuing their prey after the manner of their mammalian namesake. They are very common, numerous species occurring in China.

The little jumping spiders (*Salticidæ*) also are common. They may be looked for on window sills, walls, fences and other such places, where they lie in wait to pounce upon their unsuspecting prey.

* Recently a paper has been published by Mr. Ralph V. Chamberlain in *The Proceedings of the United States National Museum*, (Vol. 63, Art. 13, pp. 1-38, pls. 1-7) in which he describes forty-seven species of spider from various places in China, twenty-five being new to science. In "Through Shên Kan" (pp. 205-218) by R. S. Clark and A. de C. Sowerby, describing the Clark Expedition into North and West China, Mr. H. R. Hogg describes a number of spiders taken on that expedition in the Ordos region, of which five species were new. This was in 1912.

The crab-spiders (*Thomisidæ*) have fat bodies (abdomens), and are to be found mostly on bushes, hiding on the leaves, or even in the flowers, frequently being coloured to match their surroundings.

The well-known garden spiders (*Epeiridæ*) build huge webs of geometrical design to catch various flying insects. Many other spiders do likewise, and in China we have a number of very beautifully coloured species that may be met with in our gardens.

Some spiders, such as the members of the family *Dysderidæ* live under stones, where they hunt their prey.

The water-spiders (*Argyroneta*) build tent-like webs amongst the fronds of weeds in ponds and streams, and fill them with air carried from the surface in big globules on their abdomens. They lay their eggs and hatch their young in these caisson-like dwellings. They belong to the family *Agelenidæ*, which includes the house-inhabiting spiders (*Tegenaria*). These, and many more families are all well represented in the country, but to enumerate them will serve but little purpose, since one cannot give their scientific names, and they have no popular ones. The mating and breeding habits are particularly interesting. Cruel and ruthless wives though they may be, female spiders are nevertheless devoted mothers, and many are the shifts to which they resort to guard their young. One builds a nest securely in some hidden corner. Another (wolf-spider) lays her eggs in a ball of silk which she carries round with her. Some of the larger members of this group carry their whole families on their backs. I have actually been threatened by a large species of spider that had a tubular web nest that I disturbed in a bush. The infuriated creature rushed out at me as I brushed the bush in which it had its nest, and presented a fearsome aspect with its front legs uplifted, its body raised and jaws gnashing.

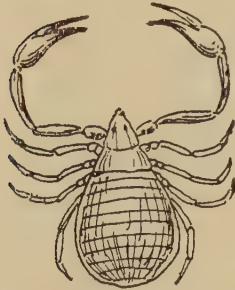
Certain young spiders spin silky webs which they let out into the breeze and use as parachutes to waft them on long journeys to new homes. This is the cause of gossamer.

China has her trap-door spider as well, and a whole host of other species, too numerous to mention. We must leave them and pass on to other arachnids.

Next to the spiders come what are known as the false-scorpions (*Chelifer*). These bear a distinct likeness to true scorpions externally, except that they lack the long drawn out abdomen and

sting. They have powerful pincer claws. Their size is not great, however, being less than a quarter of an inch in length. They feed upon small insects, lurking under stones, in cracks in walls, and occasionally in human habitations. I have frequently found these little creatures buried in the fur of rats and mice that I have trapped in the country, and apparently they infest these mammals in order to devour the ticks and mites that also infest them. They belong to the order *Pseudoscorpiones*.

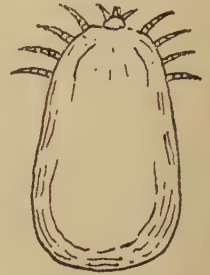
Somewhat resembling spiders with fat, round bodies and excessively long legs are the so-called "harvest-men." Often these are erroneously called "Daddy-long-legs" spiders, but they are in reality more closely related to the ticks and mites. A number of species are common in China. They are to be found under stones or old logs, or clinging to the trunks of trees, the



THE FALSE SCORPION
(Enlarged)



THE COMMON TICK BEFORE
GORGING (Greatly
enlarged)



THE COMMON TICK
AFTER GORGING
(Enlarged)

bark of which they closely resemble in colour, and where they are well hidden. The order to which the harvest-men belong is known as *Opiliones*.

The order *Acari*, containing the ticks and mites, is extremely well represented in China, but so far only a few of the numerous species have been described or classified.

Ticks are usually much larger than mites, and they have the horrible habit of fastening themselves to some luckless victim and sucking its blood. The tick's body gradually swells up till it is many times its original size, and finally it drops off its host, leaving a painful inflamed wound in the place where its head was buried within the tissues of the body. In all wooded or brush-covered areas, a species of tick of the genus *Haemophysalis* is extremely common, and gets on to men as well as animals. It is

closely related to the Japanese form *H. japonica*, but is smaller. All kinds of woodland animals are attacked by this loathsome creature, and in a country like Manchuria it is impossible to keep free from it. One of the methods by which soldiers detect a man to be a bandit is by looking for the marks of tick bites, which inevitably occur on a man who has spent much time in the forest.

Sporting dogs suffer considerably from these creatures, which get between their toes and make them lame, or fasten themselves about the head and ears of their victims, causing considerable pain. The disease so common amongst foreign dogs in China, and known as "worms in the heart," is propagated by one of these ticks: formerly it was thought to be carried by a mosquito.

The members of the family *Ixodidae* to which this tick belongs are noted for their disease carrying propensities. The fowl tick, of which the Chinese form is known as *Argas reflexus* spreads spirillosis amongst the occupants of the chicken roost, while the cattle ticks (*Margaropus*) spread fever amongst cattle.

Most rodents in China carry ticks and mites. *Laelaps agilis* is found on rats, both the common form of human habitations and its wild congeners. I have taken a species of *Leiognathus* from the body of the mole-rat (*Myospalax*). Mites also are very abundant in this country, and there are a number of zoologists in China working upon this group of "insects."

The brilliantly coloured velvety mite *Trombidium*, which is parasitical, when young, on "harvest-men," later feeding on aphides, is very common. This is a bright crimson creature, frequently to be seen running about on the leaves of plants.

Mites occur in all sorts of peculiar places, and are not always harmful to their hosts. One remarkable instance is that of a very small mite that frequents in large numbers a cavity in the abdomen of a large species of bee, where it apparently does no harm. It is thought, on the contrary, that it is actually beneficial in helping to keep the bee clean, possibly devouring other parasites.

Beetles, especially scarabs, are frequently found to be infested with mites of the genus *Gamasus*, a common form being *G. coleopratorum*.

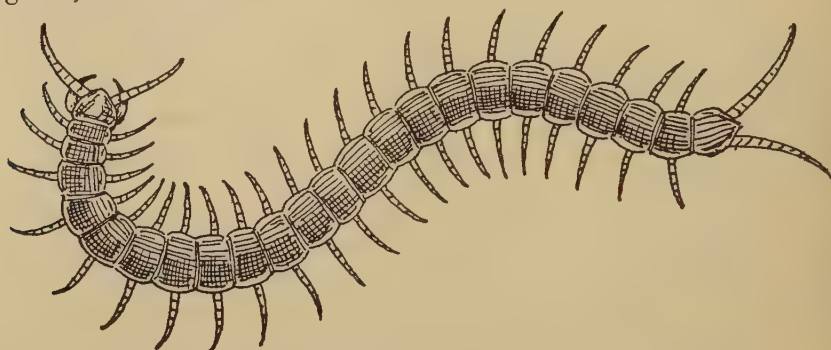
There are also water-mites (*Atax*), which live parasitically on such insects as the water-scorpion.

Certain forms of mite, such as the itch-mite (*Sarcoptes*

scabiei) are responsible for skin diseases, itch, scabies, and the like. These are excessively minute, and burrow about under the skin of their victim, depositing numerous eggs, and emitting inflammatory poisons. Some forms, such as *Demodex folliculorum* occupy the hair-follicles of the human skin, doing little damage, however. These latter are worm-like, having lost all their legs.

Passing from the ticks and mites, we come to the *Myriapoda*, a large class of arthropods including, as already explained, the centipedes, millipedes, and their relations.

With a very bad name for being poisonous the members of this group have a rough time of it so far as humans are concerned. Some, it is true, are very poisonous, and deserve all they get, but the majority are not. On the contrary they are actually beneficial to man, since their food consists of such noxious insects as mosquitoes, cockroaches, bed-bugs and the like, which they catch and devour on their nightly wanderings. Indeed, even the largest and most poisonous kinds are predaceous and devour all kinds of beetles, grubs, and the like.



THE GIANT CENTIPEDE OF EAST AND SOUTH CHINA. (*Reduced*)

In Central and South China we have species of centipede that attains a large size—8 to 10 inches—which is very poisonous. It belongs to the genus *Scolopendra*, noted for the large size of its members. A smaller form is *Cryptops*, which is proportionately shorter. The members of this genus extend far to the north, being met with in Siberia. In both these genera the legs are short, each ending in a poisonous claw, while the head is provided with powerful poison jaws.

The worm-like centipedes (*Geophilus*), should be familiar to all. They are very long and slender, with numerous minute

legs, and are often to be seen when digging in the garden. They feed upon earthworms, which they attack with great ferocity, twining round the luckless victims (many sizes larger than themselves) and stinging them to death with their poisoned claws.

Common in houses are the various species of long-legged centipedes (*Scutigera*). These, as the name suggests, have very long legs, and are not nice looking creatures at all. They are absolutely harmless, however, and since they feed on mosquitoes, should be left alone. Some very brightly marked forms occur in South China, the northern form being of a dull yellow-grey colour.

The millipedes and pill-millipedes differ from the foregoing form in having a much more effective armature. They are sometimes separated as a different class *Diplopoda*. The millipedes are characterized by having a great many more legs than, even, the centipedes. In them the back is rounded, the legs being placed well underneath the body. All forms have the habit of curling up like caterpillars when alarmed. A very handsome form of *Iulus*, large, and banded black and bright yellow, ranges as far north as the Imperial Hunting Grounds in Chihli, where also a smaller black form occurs.

Pill-millipedes of the genus *Glomeris* occur in China. They closely resemble in external appearance wood-lice of the genus *Armadillidium* (a land-inhabiting crustacean), being able, like it, to curl up into balls, hence the name.

There are also a number of aberrant millipedes in these parts. All are harmless, however, none being poisonous. Their food consists entirely of vegetable matter.

CHAPTER XXVI.

BEETLES THAT MAY BE FOUND IN A GARDEN IN CHINA.

The study of insect life is probably one of the most important branches of natural science. The reason is very simple: insects form man's greatest enemies in the world of animate nature. It is only by acquiring a knowledge of them and their ways that means of destroying them can be discovered. The farmer and gardener are inclined to scoff at the naturalist, or bug-hunter, as they contemptuously call him, but in the end it is the biologist who comes to the aid of both in their fight against the myriad hosts of winged pests.

In contemplating the lot of the husbandman, he whose business it is to make the willing soil yield her bounteous store for man's welfare, and his eternal warfare against insects and other noxious creatures that infest his garden and fields, one is reminded of the lines, written by one knows not whom:—

A garden is a loathsome thing—eh what?
Blight, snail,
Pea-weevil,
Greenfly, such a lot
My handiest tool
Is powerless, yet the fool
(Next door) contends that slugs are not.
Not slugs! in gardens! when the eve is cool?
Nay, but I have some brine
'T'is very sure they shall not walk in mine.

The pathos, one might almost say tragedy, expressed in this clever parody must appeal with irresistible force to many an amateur gardener in China where insects are so numerous and varied. A garden, free from insect or other pests, wherein blight has no place, and slugs are not, is, indeed, a lovely thing, but what a wilderness it may become if neglect be its portion, or its keeper be worsted in his war against the insect world? How

quickly will it be invaded by the countless winged horde, whose grubs, rapacious with an unappeasable hunger, will eat many times their own weight of green foliage, juicy root-bulb, or even woody stem in the course of their short but greedy lives, destroying whatever they touch. How delicate shoots will suddenly wither and die as the result of the subterranean tunnellings of chafer-grubs, or blossoms fair wilt before their prime because of the borings of weevils! Once beautiful leaves become spotted, curl up, and wither at the touch of blight, or disfigured by the ugly warts of gall-wasps. Stately trees may turn brown and shed their leaves long before autumn makes that demand, for their hearts have been eaten out by the scissor-jawed grubs of longicorn beetles; ripening fruit falls early to the ground, because maggots have penetrated their cores. Graceful plants are stripped bare by loathsome caterpillars; webs, other than those of my lady spider, spread their clinging threads over every thing; and well might one cry "Ichabod! Ichabod! the glory has departed from this once fair spot, where God was wont to walk when the eve was cool."

And yet Fabre, the great French naturalist, deliberately chose a garden where insects held full sway—and wisely did he choose. He desired to study the ways of man's worst enemies, not, it is true, with a view to accomplishing their ultimate destruction, but because he loved them, and found in the study of insect life the fulfilment of his own destiny and genius. Shall we blame him for this? After all, a world bereft of insects would lose much of its charm. What though the caterpillar strips your choicest plant, and leaves its withering stem stark and bare; does it not later turn into that gorgeous butterfly that flits across your lawn and vies with the very blossoms it visits in its gay and irresponsible existence? And the rose chafer with its brilliant armour of emerald green flashing in the sunlight like a living gem, is it not ample compensation for the withered tuft of pinks?

The philosopher who recognizes that there is a time and place for all things, and that Nature always compensates, will find it in his heart to forgive the canker when he views with a thrill of pleasure the imago, or perfect insect, in all its exquisite beauty.

A garden is a lovely thing, and not one jot less lovely for

the denizens it harbours, so be that they are kept within bounds. Let us walk in our Chinese garden with open eyes, enlightened minds, and senses alert to grapple with the wonders of the insect world that it must inevitably contain. Put away that handy tool of destruction, and prepare to learn something of Nature's secrets.

The word insect, like many another used in zoology, has come to have a more restricted meaning than it used to have, and it is well to make sure that we understand exactly what we mean when we use it. A spider is not an insect, nor is a centipede, nor yet a scorpion. An insect is an arthropod, or animal with jointed legs, in which there are but six legs, three on either side of body, and in which the body is divided into three main sections, the head, the thorax, or prothorax, and the abdomen. The last is, of course, made up of a number of segments. An examination of a spider will reveal the fact that there is no separate head, this and what would be the thorax in an insect being joined to form but one section. The abdomen is not segmented. There are eight legs, four on each side. The scorpion also has eight legs, and the head and thorax joined, but its abdomen shows segmentation. Centipedes and their kind have numerous legs and segments to the body. Thus very simply is an insect defined.

If mere numbers of species that occur in the world be a sign of success, then the class *Insecta* is the most successful of all Nature's undertakings. There are more species of insects in the world than species of all the rest of living things put together. Their number runs into hundreds of thousands, and every year it is being added to as naturalists push their explorations further and further afield. It is only the mechanical impossibility of their attaining any degree of size that has prevented them completely dominating the earth, and preventing any other higher forms of life coming into existence. When Nature evolved the insect she produced a marvel of specialization, but it had its limitation, that of size, and so other creatures were evolved in which the limit of size was much greater, and the insect was left to multiply enormously and to fill the earth with its hosts, but always to remain subservient to the later and higher creations. As a matter of fact a bid for size appears to have been made in the insect world, for there are certain geologic strata that con-

tain the fossil remains of dragonflies with a two foot stretch of wing and an eighteen inch body, but it could not have been a success. Failure to produce size seems to have given a strong impetus to evolution along another line, namely that of instinct, and insects became the world's instinct specialists. Some of them have developed a social state, apparently purely controlled by instinct, that is second only to that of man himself, while most of them perform series of actions, purely dictated by instinct, that a much higher organism operating with what might be called a truly thinking brain would fail to accomplish. . . . at least Fabre claims that insects work entirely by instinct, though there are times when one cannot altogether agree with the great French naturalist who made insects his life's study. But more on this point when we come to an examination of bees and ants.

Off hand it would not be easy to say which of the great insect orders predominates in a garden in these parts, but the honours certainly lie between that of the beetles (*Colcoptera*), that of the butterflies and moths (*Lepidoptera*) and that of the flies (*Diptera*). Bees and wasps, which belong to the order *Hymenoptera*, insects with membranous wings, to which also belong the true ants, will also be found plentiful; while many a "bug," by which name the *Hemiptera*, or half-winged insects are popularly called, will be discovered. Members of the order *Orthoptera*, straight-winged insects, that is to say, grasshoppers, crickets, mantises, and the like, will not be found over abundant: their haunt is more the open field and meadow.

A collection of insects made in a Shanghai garden and now lying in the museum of the Royal Asiatic Society, shows a great preponderance of butterflies and moths, with beetles a poor second, but this in all probability is due to the personal predilections of the collector. Beetles probably outnumber any other insects in a given area with the exception of marshy ground. It has been estimated that there are over 300,000 different species of beetle in the world—a number which cannot be approached by any other order of insects. And yet, to the casual observer, this would scarcely be apparent, for beetles have lurking habits. They hide under stones and logs; they burrow into the earth; mostly they avoid exposing themselves, which is quite contrary to the habits of butterflies, who love display, or flies, whose impudence is only surpassed by the determination they evince to force themselves upon one's notice.

It is to the half-turned clods of earth or the cracks in the bark of old trees, then, that we must look to find our coleopterons, though, of course, there are a number of kinds of beetle, usually brilliant in colour, such as the chrysomelids, that may be found feeding boldly upon plants growing in the open. The majority of beetles are nocturnal in habits.

The largest beetle found in these parts is the Atlas beetle (*Xylotrupes dichotomus*), which belongs to the group called *Clavicornia*, or beetles with knobbed antennae, and whose relations are the scarabs or dung-beetles, shard-beetles, and burying-beetles. The Atlas beetle may attain the size of a small



THE ATLAS BEETLE (*Xylotrupes dichotomus*)

hen's egg, is armed on the head with a long horn that branches at its extremity, giving the creature a formidable appearance. It is closely related to the copris beetles, whose rhinoceros-like horns are not branched. The members of this group are not only harmless in a garden, but actually beneficial, since their habit of making up balls of dung, in which they lay their eggs, and burying them greatly assists in fertilizing the soil. They may be repulsive in appearance and habits, but should not be destroyed on that

account. Rather should they be encouraged. As a matter of fact, some of these beetles are brilliantly coloured with rich blues, purples, crimsons, and greens, and have a metallic lustre, though most of them are sombre. Recently a fossil beetle has been found in the Lower Cretaceous rocks of Shantung. It is a member of the *Scarabidæ*, and has been called *Protero-scarabæus yeni* after Dr. W. W. Yen, who has done so much for geological work in China. This is a very interesting discovery, and gives us a good idea of the age of the whole order of beetles.

Another large beetle to be found in local gardens is the giant longicorn, *Batocera lineolata*. This ferocious looking insect, with



THE GIANT LONGICORN (*Batocera lineolata*). Reduced



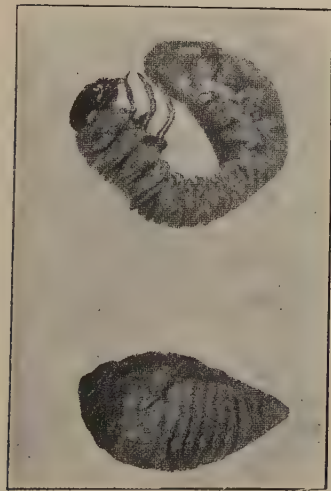
THE CARNIVOROUS GROUND-BEETLE (*Coptolabrus*)

jaws that could cut one's finger to the bone and long jointed and tapering antennae, belongs to a group known as *Longicornia*. The longicorns form a veritable pest. Their larval stage is spent inside the trunk of some tree, and the havoc wrought by them is immense. Our species, of a brown colour, somewhat speckled with black, or a deeper brown, often makes its appearance at night, blundering into the verandah or dining room, apparently attracted by the light. It is always very angry and ready to fight, tearing about in a mad sort of way, its powerful jaws working, and making a peculiar squeaking noise when touched. By day it may be sought on the

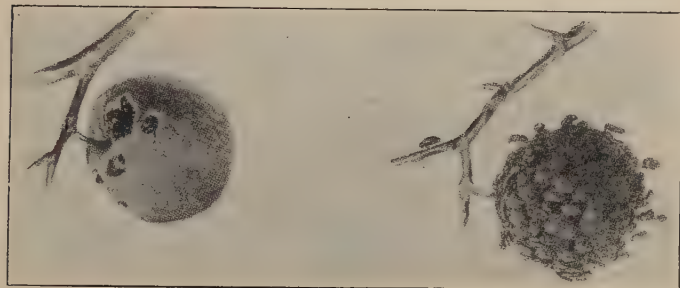
trunks of large trees. On the trunks of willows a close relation of this species may be found. This is the large shiny black longicorn with white spots on the wing-cases and white bands on the antennae. It is known to science as *Melanauster chinensis*. In both species there is a sharp spine on each side of the thorax. Some of the smaller members of this group will attack a tree in such numbers as to kill it in a single season. Conifers are particularly susceptible to the attacks of longicorns.

The chafers, of which a great many different kinds occur in gardens, since they are fond of flowers, are particularly noxious, their grubs, hideous humped white maggot-like creatures, living under ground and feeding upon the roots and subterranean stalks of various plants. Of them all the Chinese equivalent of the "June-bug" or "May-bug" of the homelands is the worst. Its name is *Euchlora virides*, and it varies in colour from brown with a green metallic wash to a bright metallic green. The most beautiful member of the group out here is the Chinese rose beetle (*Cetonia chinensis*), which is a large brilliant green form: the largest is a species with enormously elongated anterior legs. The common cock-chaffer (*Melolontha vulgaris*) is very abundant in these parts. A small species to which has been given the name "Japanese beetle," known to science as *Popilia japonica*, has recently secured a footing in the Eastern United States where it is doing incalculable damage. Attempts are being made to find in Japan or China a parasite of this beetle, which, if introduced into the affected area in America may exterminate or at least control the pest. As the beetle is common in the Shanghai district, where it occurs at times in great swarms, those inclined to do so may assist in the search for the required parasite. It has been found that the use of parasites is the most effective way of controlling insect pests. The members of the group to which these beetles belong may easily be recognized by their very weak jaws, and antennae with a set of fan-like plates at the tip instead of a knob. On account of the latter fact they are called *Lamellicornia*. The presence of the noxious grub may be detected by the complete withering away of young plants for no apparent reason, and steps should be taken at once to remove the nuisance, or many plants will be destroyed before the larva develops into the mature insect and comes above ground.

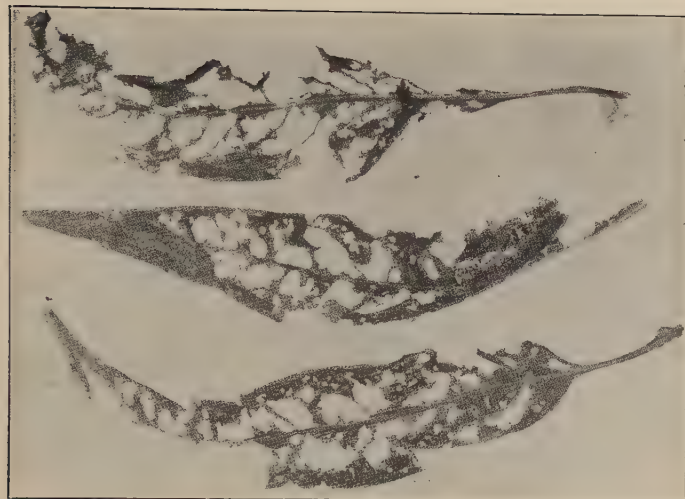
Weevils, too, are very destructive. The members of this



LARVA, PUPA AND ADULT OF THE JAPANESE
BEETLE (*Popilia japonica*)



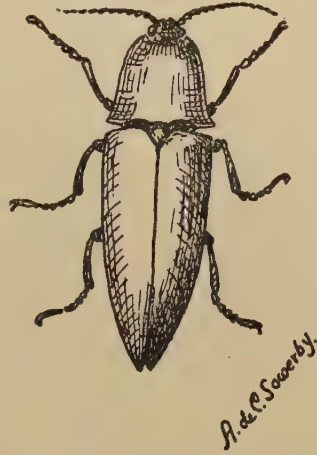
THE JAPANESE BEETLE AT
WORK ON AN APPLE



LEAVES EATEN BY THE JAPANESE BEETLE

(From reproductions in The Nature Magazine)

group, *Rhynchophoria*, are so called because of the peculiar way in which the head is drawn out into a snout, in some cases of considerable length. They range in size from the "bamboo monkey" a large chestnut brown form found on bamboos, down to species no larger than a pin's head. All, or nearly all, are noxious. They get into peas and other cereals; they are found in meal; they attack the roots of plants and cause swellings. Some are very beautiful indeed, being of pale shades of green or mauve with iridescent sheens. Others are beautifully mottled. A species found in China on ailanthus trees has its armour peculiarity roughened, and variegated black, white and brown, so that it closely resembles the bark of the tree on which it lives.

THE BAMBOO MONKEY (*Rhynchophorus*)THE GIANT CLICK-BEETLE (*Buprestis*)

Water-beetles might hardly be considered as usual denizens of the garden, yet in cases where artificial waters are present they will inevitably appear. They must not be confused with water-bugs, which are aquatic members of the order *Rhynchota*, or *Hemiptera*, already mentioned. A glance at their wings will show the difference. There are two groups of water-beetle, namely, *Hydrophaga* and *Palpicornica*. They are mostly harmless enough, but one kind called *Dytiscus* is very ferocious and will attack small fish, which fact renders it undesirable for fish ponds. This is the largest form, and it is of an uniform blackish colour.

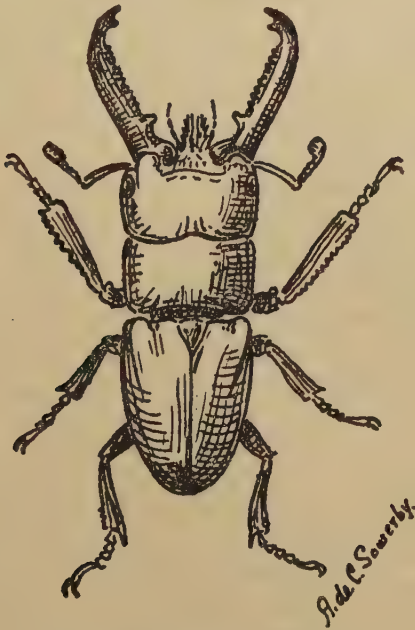
An interesting group of beetles are the ground-beetles, *Geodephaga*, so called on account of their ground loving habits. Some cannot even fly. They are predacious, and capture their prey literally by running it down. They are the deadly enemies of slugs, snails, caterpillars, grubs of all sorts, and even other beetles, and so should never be destroyed. They never harm plants. The largest members of the group, that is, members of the genera *Coptolabrus* and *Carabus*, are almost invariably brightly coloured—green, crimson, or bronze, with beautiful metallic and iridescent sheens. They may be found at night scouring the garden for their prey. Certain smaller members of the group are known as “bombardier beetles,” because when alarmed they discharge a noxious fluid at their enemy with a short explosive sound. The fluid being extremely volatile turns into gas on contact with the air, so that this method of defence is literally an insect gas attack. Sometimes on turning over a stone four or five of these beetles will be found underneath, and the effect of their little explosions is that of a miniature battle, as each insect seeks safety in flight, firing as it goes.

More or less harmless are the beetles belonging to the group *Phytophaga*. These are mostly small, rounded, and very brilliantly coloured. They are generally known as chrysomelids, and are usually to be found in clusters feeding upon plants with milky sap. There is one very beautiful species common in these parts, which is of a bright greeny blue, sometimes pure blue. Another has bands of crimson, gold, and green on the wing-cases.

The members of the group *Trimera*, commonly known as “ladybirds,” are probably the most beneficial insects to be found in a garden. The food of the ladybird’s grub consists of green-fly, or *Aphides*, so destructive to roses and other flowering plants, not to mention many shrubs. They eat the tiny mites that do such harm to cucumbers. Fruit blight they love, and there is no surer way of getting rid of this nuisance than by encouraging ladybirds to infest the trees that are affected. For this reason it is important that one should not fail to recognize the ladybird’s larva. About a quarter of an inch in length, or perhaps a little longer, according to the particular species, the grub of this beetle is somewhat torpedo-shaped, flattened on the under side, and covered with tiny black spiny processes. The head is small, and there are six well developed legs. The little creature may be seen

running rather rapidly over leaves and stems in search of its prey, which it seizes and devours greedily, leaving the empty shell.

This by no means exhausts the list of beetles to be found in a garden in China. There are the various kinds of stag-beetle (*Lacunas*), of which several species are to be met with in these parts. They should be looked for on trees and large shrubs, especially members of the oak family. The grub lives in the decayed parts of branches or trunks, spending some five years of its existence there before maturing. They are not very numerous, and such handsome beetles as these might well be left alone, as, after all, they do not do a great deal of damage. Then



THE CHINESE STAG-BEETLE (*Lacunas*)

there are the click-beetles, and their kind, some of which are extremely beautiful, their shining armour being of bright iridescent greens and gold. Others are extremely harmful to plants, as their grubs live a subteranean life and devour living roots. The notorious "wire-worm," the farmers' particular enemy, is a grub of one of the click-beetles. They are called click-beetles because they have the power of clicking the joint between the thorax and

abdomen in a peculiar manner, and when on their backs, by exercising this power can shoot into the air. The brilliant green forms are all members of the genus *Buprestis*, some species attaining a considerable size. One would hate to see such beautiful insects as these destroyed. After all it does not pay to be too utilitarian in life—man has other, and we might well say higher, sides to his life and activities than merely to get as much as he can out of the soil in the way of food. To some the aesthetic side is by far the most important, and such creatures as one of *Buprestidæ* cannot fail to appeal to the aesthetic side of anybody's nature.

Besides these numerous species of beetle there are the wood-boring beetles of the group *Teredilia*; the cellar-beetles, *Heteromera*; and the fire-flies, *Malacodermata*, which are not flies at all, but beetles, to which our little English glow-worm is closely related. Of these the two former groups are not as a rule represented in the garden, and would be harmless enough if they were: they are household insects, the *Teredilia* doing considerable damage to furniture and interior wood work. The cellar-beetles are beneficial since they are by way of being scavengers.

Thus, taking them as a whole, the members of the order *Coleoptera* are more useful and beneficial in a garden than the reverse, the longicorns, the weevils, the chafers, and the click-beetles being the offenders, and most of the rest either harmless or distinctly beneficial.

CHAPTER XXVII.

THE CHINESE CICADA AND ITS RELATIONS.

I am distraught. I want to write of butterflies and moths, but cannot make a beginning, for there sits upon the lattice of my window a cicada, whose shrill notes drive all thought from my head. Can it be that any human ever found music in this insect's rasping song? It is claimed that the Chinese love the song of the cicada, and to judge from the way one sees small boys hunting the creatures in the trees with long bamboos and nets, one might well believe it. Still, to us ignorant westerners it is incomprehensible that any human being, short of a pure savage of the jungle, could willingly submit his ears to the torture of the scissor-grinder's love song. Yet the Ancients appear to have appreciated the insect's musical efforts, for we have Anacreon's ode, ably translated by Green, the which I have culled from the pages of an old book—classic now, and rare withal. Listen!

Happy creature! what below
Can more happy live than thou?
Seated on thy leafy throne,
(Summer weaves the verdant crown)
Sipping o'er the pearly lawn
The fragrant nectar of the dawn;
Little tales thou lov'st to sing,
Tales of mirth—an insect king:
Thine the treasures of the field,
All thy own the seasons yields;
Nature paints for thee the year,
Songster to the shepherds dear:
Innocent, of placid fame,
What of man can boast the same?
Thine the lavished voice of praise,
Harbinger of fruitful days;
Darling of the tuneful nine,
Phoebus is thy sire divine;

Phoebus to thy notes has giv'n,
 Music from the spheres of heav'n :
 Happy, most, as first of earth,
 Cares nor pains to thee belong,
 Thou alone art ever young ;
 Thine the pure *immortal* vein,
 Rich in spirits—health thy feast ;
 Thou'rt a demi-god at least.

The same book tells of an ancient legend of Greece, which runs :—Once a certain player of Locri, who was engaged in a musical contest with a rival, broke two of the strings of his instrument. This would have cost him the victory, but for the fact that a cicada settled upon his instrument and began singing with such power and sweetness that the victory was given to the man of Locri. So grateful were the Locrians to the cicada that they erected a statue representing the player with the insect upon his instrument in token thereof.

The cynic might remark that this constitutes a very interesting and significant commentary upon the playing and music of the ancient Grecians, but the story is a pretty one, and who shall say that there is no music in the cicada's song? If, then, the Ancients of Greece and the Chinese of to-day can appreciate this insect's instrumental performances, who am I to find fault if one comes and settles on my window and plays for my edification? But I cannot write of butterflies, so I must perforce devote my time to cicadas and their kin. It matters not; the butterflies can wait, and after all the members of the order *Rhynchota* are just as interesting as those of the order *Lepidoptera*. Perhaps they may be found more interesting, for they are very diverse in their forms and habits, while the butterflies and moths have little to recommend them to our notice beyond their sheer beauty.

The members of the order *Rhynchota* are characterized by having the mouth modified into the form of a long tube for piercing and sucking, hence the name. There are two sub-orders, *Hemiptera* and *Homoptera*, the former, as the name suggests, having the wings half leathery and half membraneous, the latter having them entirely membraneous. The cicada belongs to the *Homoptera*, as also do the froth-insects, or cuckoo's spit, and the plant-lice, *Aphides*, or green-fly. The remarkable lantern fly, or

Fulgora, about which more later on, also belongs to this group, as well as the peculiar scale-insects and the wax-insects. To the *Hemiptera* belong the bush-bugs, the tree-bugs, the bed-bugs, and certain aquatic forms such as the water-scorpion and the pond-scater. It will be seen, then, that the order, in the matter of variety of forms and adaptations, is unique. It contains species that resemble moths, others that resemble beetles, and yet others that resemble mantises and other orthopterous insects. Many forms are brilliantly coloured, not a few are poisonous, as poisonous as bees and wasps. The bed-bugs are wingless and parasitical. In fact, there seems to be no phase or adaptation of other insect life that they have not tried or imitated. And all the many forms, with the exception of the parasites, are to be found at some time or other in the garden in China, that is, if it is large enough and has a pond.

At the time of year when he is about the cicada undoubtedly attracts the most attention, for besides being so large an insect he is such a noisy one that no one can avoid him. Sitting high up on the trunk or a branch of some tree he pours forth his music incessantly from dawn to dusk, basking in the warm rays of the sun, and sucking continuously the sap from the tree. His mate, who lacks a musical instrument, sits besides him, and who shall say she does not enjoy his performances? Fabre maintains that cicadas are unconscious of sound, because he fired a gun in close proximity to a number that were perched upon a tree and singing without disturbing them in the least. Also no auditory organs have been found in the cicada. But does it follow that these insects are non-receptive of any sensation produced by the vibrations of the male's drums and cymbals? Sometimes Fabre is very unconvincing in his deductions, albeit so fine an observer. May it not be suggested that sound conveys no sensation to the cicada but pleasure, and that sound and fear are in no way connected with each other in his consciousness? Is it not rather inconceivable that a sound-producing instrument of so perfect a nature should have been evolved in the male only with no other purpose in view than to afford the insect pleasure in the making of the noise, he himself being unable to hear it when produced? It is a rule throughout the animal kingdom that where characters are possessed by the male only, they have a strong sexual bearing and

significance, and are in some way connected with the mating instinct. Thus the stag has horns in order to fight other stags for the possession of the doe, and the peacock has a wonderful display of plumage to attract the peahen. There is no other conceivable purpose for the male cicada's musical box than to attract the female who has none, and though sound-receiving organs have not yet been found in these insects, we must suppose that it is only a matter of time and close investigation for them to be discovered.

The cicada has wonderful sight, and who would not who had five eyes? Beside the two fine compound eyes there are three simple ones, situated cyclopean-wise in the middle of the forehead. These together enable the insect to detect the approach of a stranger in a way no other insect appears to be able to do, and here we find the sense intimately associated in the creature's consciousness with fear, for the cicada is extremely difficult to approach.

There is no need to describe the cicada's appearance: everybody in China must be familiar with it. It might be stated that the noise-instrument consists of two membranous cymbals or drums situated behind the wings on the back, and they are made to vibrate by means of a muscle within the body. The sound is greatly increased by the presence of plate-like shields upon the under surface of the body which act as sounding boards. The peculiar triangular head, and the long transparent wings render the cicada unmistakable.

The life history of this insect is well-known. The female lays her eggs in little pits made in the soft bark of a branch of a tree with her proboscis, according to Fabre. She lays them in groups of from ten to thirty in a group, altogether depositing some three or four hundred. When the eggs hatch out, the young moult, and then find their way to the ground where they burrow below the surface. Sometimes they penetrate to a great depth, it is said, as much as fifteen feet down. The grub makes a burrow for itself, situated along and above some juicy tree-root, which it punctures and from which it sucks the sap. Four years it stays in its subterranean home, and then comes out in the form of a motile pupa, climbs up the stem of a bush or the trunk of a tree, splits down the back, and emerges a perfect insect. This rising, as it were, from the grave was noticed by the ancient Chinese, who



A GROUP OF CHINESE HOMOPTERA

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|---|--|
| 1. WAX INSECT LARVA (<i>Flata nigricornis</i>) | 6. SMALL CICADA |
| 2. WAX INSECT ADULT (<i>Flata nigricornis</i>) | 7. FROG-HOPPER (<i>Philænus spumarius</i>) |
| 3. LARGE CICADA (<i>Cicada atra</i> , FAB.) MALE | 8. CHINESE LANTERN FLY (<i>Fulgora candelaria</i>) |
| 4. LARGE CICADA (<i>Cicada atra</i> , FAB.) FEMALE | 9. A LADYBIRD BEETLE DEVOURING |
| 5. LARGE CICADA (<i>Cicada atra</i> , FAB.) LARVA | 10. PLANT LICE (<i>Aphis</i>) |

saw in the cicada an emblem of immortality, and, according to Dr. Laufer of the Field Museum of Natural History, it was for this reason that the mouth jade piece of earlier Chinese dynasties was usually carved in the form of a cicada. For the sake of the uninitiated it may be mentioned that in those bygone days the Chinese buried their dead with a piece of carved jade in each of the nine orifices of the body, since jade represented immortality, and it was thought that by so doing the body would be preserved. The mouth pieces, which are usually the general shape of the tongue, a shape also resembling the cicada, are known as *Han* jades, and this has led to a certain amount of confusion in the minds of Europeans, who have thought that the word *Han* referred to the Han dynasty. Thus, though the cicada had a considerable significance for the Ancients of Europe, it had a far greater one for the Ancients of China.

There are numerous different species of cicada in these parts of China. The large species common to our gardens appears to be *Cicada atrata* of Fabricius. The species range in size from this large insect down to forms no bigger than a fly. Some are of exquisite beauty. The other day while sitting on the verandah of the French Club I noticed one small species whose broad wings were a marvel of brown, lace-like tracery.

Closely related to the cicadas are the froth-insects, which, when in the larval stage cover themselves with foam exuded from their bodies. It is this that gives them their common English name of cuckoo's spit. The mature insect is the little green creature commonly seen on one's dining table on summer evenings, having been attracted thither by the light.

One of the most remarkable insects in China is the lantern fly, or *Fulgoria candelaria*. A large insect, this species is of a pretty green colour banded with yellow, its under wings being yellow tipped with black, and abdomen yellow barred with black. It is remarkable in that it has the head drawn out into a long horn-like snout, the tip of which is said to be luminous. The insect thus flies about of an evening with a fine lantern held well in front, which, one must suppose, aids it in its search for food or a mate. This snout is of a fine red colour. I am not aware of this insect's occurrence so far north as Shanghai, but it appears to be fairly common in Fukien and other parts of the south. In the north a small species of much the same shape, but a dull drab colour

occurs, but whether or not it is luminous I have not ascertained. This belongs to the genus *Pseudophana*.

Every gardener is familiar with the green-fly, or plant-louse. It is too prevalent to be a stranger, indeed, one's greatest concern is how to get rid of it, for it amounts to a scourge in some gardens. But, apart from the nuisance that it is, it is a very interesting insect in more ways than one. In the first place its associations with ants renders it remarkable. The aphid is virtually the ant's cow, and is cared for and milked by the ants in much the same way as we care for and milk cows. By gently caressing the green-fly's back with its antennae, the ant causes it to exude a sweet fluid called honey-dew from two upstanding tubes, which fluid is sucked up by the ant. Not only does the ant thus "milk" the plant-louse out in the open, some kinds of ant carry these insects away and keep them under ground. It is no uncommon thing to see swarms of ants running up and down the stalks of plants where aphides are numerous; a goodly feast awaits them.

But probably the most interesting thing about plant-lice is their method of reproduction. The summer broods of these insects are produced by the females without any fertilization by males, they are born alive, instead of as eggs, and are all females. This means of reproduction is called parthenogenesis. It is not till the autumn that males are born and fertilization takes place, after which the brood that shall carry through the winter is produced in the egg state. This virginal reproduction of individuals is one of the most interesting phenomena in the insect world, where, and in a few lowly crustaceans alone, it occurs. It seems as though this parthenogenetic and viviparous method of procreation is to enable the aphid to reach the maximum reproduction during the summer, which, by the way, is enormous. The offsprings of a single female green-fly may run into billions during one season.

How many species of aphid there are in China has never been determined, but there must be an enormous number, since in Great Britain, a far smaller country, and one with a much more uniform climate, there are over two hundred species.

Closely related to the aphides are the scale-insects, which also are in many cases a pest. They are small whitish insects, that look like scales upon the leaves of the plants they infest,

and they do considerable damage. The chief natural enemy of both these and the green-flies is the lady-bird beetle, a fact noted when discussing beetles. The gardener should on no account discourage the lady-bird, rather should he look upon her as his most valuable ally.

Before passing on to the other *Hemiptera*, mention should be made of the far-famed wax insect, which is found in South and West China, and from which the Chinese derive a fine white wax of exceeding purity. This insect is closely allied to the cicadas, at one time being placed by naturalists in the same genus. It really belongs to the *Fulgoridæ*, however, being related to the lantern-fly. Its scientific name is *Flata nigricornis*, and it is a beautiful insect both in the pupal and adult stages. It is during the pupal stage that this remarkable insect produces the white wax, which spreads over its whole body in the form of a white powder. The insect in this stage has short undeveloped wings, and a mass of feathery filaments on the abdomen. It frequents a kind of privet, over which it scatters the powdery wax. This is collected by the natives and is used to give hardness to other fatty substances for the manufacture of candles. It is an interesting point to note how many of the members of the order *Rhynchota* exude substances from their bodies. The aphides exude honey-dew and also white filamentous stuff that looks like cotton wool: the young frog-hopper, or cuckoo's spit (*Philænus spumarius*) about which we have already heard, exudes a fluid which forms froth all round the insect and so protects it during a stage when its body is soft and helpless: many of the *Fulgoridæ* exude wax, as also do the scale-insects. The cicada's body is always charged with liquid, which it ejects in quantities when alarmed. It must be supposed that the food of these insects, the sap of plants, is largely responsible for this.

HEMIPTERA.

The *Hemiptera*, as already stated, may easily be recognized by the form of their wings, the upper half of the anterior wings being leathery and the distal half membranous. Looking not unlike beetles, many of these insects are common in gardens, where they may be found on the trees and bushes. They all have a peculiar and characteristic odour that is far from agreeable. Mostly their bodies are shield-shaped, and they may be recognized

by the diamond shaped pattern on their backs due to the formation of their wings. It is amongst the members of this group that the poisonous species are mostly to be found. I well remember capturing one of these insects as it settled on my arm, only to let it go immediately, for it stung me so badly as to cause considerable swelling, and acute inflammation of the part affected. This was a large black species that looked something like a wasp. The bedbug's propensities in this direction are well-known. It is a wingless member of the sub-order. Writing of bud-bugs brings to mind an interesting discovery made recently by Dr. J. G. Anderson of the Geological Survey of China in the Lu-pan mountains of Kansu. He has found fossil bed-bugs almost identical with those of the same district of the present day. Many of the bush-bugs and tree-bugs are very brightly coloured. There is one large species that resembles the gorgeous Chinese rose-chaffer in its brilliant green iridescent colouring. Others are crimson, golden, bluish, green, or merely brown, and most of them are prettily marked. Some of them are most peculiarly shaped: all are interesting to a degree, and are worth investigation, if only one can overcome one's repugnance of the smell. This, it may be remarked, is undoubtedly a means of protection against the attacks of birds. I have frequently tried young birds with these insects, and always they have been rejected. However, there are birds that will eat them, for in examining the crop of a crow-pheasant, a species of cuckoo that is very prevalent in South China, I found the remains of several bush-bugs. I have also found a bush-bug in the stomach of a wood-pecker.

The aquatic members of this group of insects are also very interesting. One of the largest insects found in these parts is amongst them. This is *Belostoma*, a truly formidable looking creature, that sometimes appears at nights on our verandahs. It is armed with sub-chelate claws, with which it catches hold of its prey—small fish, frogs, and other aquatic insects—while it feeds upon the soft tissues. This horrid looking insect is a relative of the water-scorpion, which it resembles, though being much larger, and not having the long appendages at the end of the abdomen possessed by the latter. The water-scorpion found in China is known to science as *Nepa rubra* on account of the colour of its abdomen. There are several other aquatic *Hemiptera* to be found in ponds in this country, one of the most interesting



SOME CHINESE AQUATIC HEMIPTERA

1. BELOSTOMA
2. WATER-BOATMAN (*Corixa*)
3. *Sphaerodema rustica*: A MALE CARRYING EGGS
4. WATER-SCORPION (*Nepa rubra*)

of which is a species that looks very much like a true water beetle. Its name is *Sphaerodema rustica*. The chief interest attaching to it is that the male carries the eggs upon its back till they are hatched, when the cluster of dead skins falls off. The paternal instinct thus displayed is by no means an uncommon thing amongst even such lowly organisms as insects, though one is naturally rather inclined to think that these creatures care little enough for their offsprings' welfare. But one must not lose sight of the fact that insects represent a very highly specialized branch of the tree of life, and it is no more wonderful that they should have developed this solicitude for their progeny than ourselves, albeit we consider ourselves so much higher in the scale of living organisms. It may be presumed that the same materials have gone to form the brain of the insect and the brain of man, so why should we not expect the same manifestations in each? The more we study the lives and activities of these slowly creatures, the more we realize how integral a part of animate nature we ourselves are and the more we study ourselves the more we realize how we react and respond to the same impulses and stimuli that move the beings of what we in our arrogance choose to call the lower creation.

Before leaving this group of insects mention should be made of a few other common aquatic forms. One of these, *Ranatra*, looks exactly like a long drawn out water-scorpion. It is extremely common. The well-known pond-skaters (*Gerris*) is another member of this group. The only known marine insect, a sort of sea-skater called *Halobates*, also belongs to this group. At times specimens are found in mid-ocean.

CHAPTER XXVIII.

SOME BUTTERFLIES AND MOTHS OF CHINA.

It is with considerable pleasure that one looks back upon the days of one's boyhood, and views in memory the happy hours spent in chasing butterflies and moths for the little cabinet collection that is part of the treasure store of every school boy. How one loved those gaudy-winged creatures, all pinned out in their little glass-topped trays! Each specimen had its history. This one called to mind a wild dash across moorland or thicket, and a final, breathless moment of exultation as it was taken from the net and transferred to the collecting bottle: that one, hours of patient search in secluded dells: the other, weeks of careful tending of a caterpillar, and anxious days of waiting for the time when the perfect insect should appear from out its brown chrysalis.

Even to-day, when more weighty matters call for attention, and the irresponsibility of youth has given place to the dignity of maturity, one cannot altogether lose interest in these beautiful insects, or suppress the impulse to chase after and capture them when they flit across one's path as one walks in the garden. Many of us never lose our youthful enthusiasm, and the sight of a swallow-tail butterfly, or a luna moth, exquisite creations of Nature, ever brings anew the thrill of wonderment that things so perfect can be.

The *Lepidoptera* (lit. scale-winged) are a very widely distributed and numerous order of insects. Amongst them are to be found creatures of the most marvellous beauty, children of life and pleasure, as well as small and ill-favoured skulkers in dark places, whose depredations amongst woollen clothes are the despair of housewives. The *Microlepidoptera* it may be mentioned formed the subject of a special commission of investigation because of the damage their grubs did to food during the recent world war.

The *Lepidoptera* are divided into two main groups, the butterflies and the moths, the chief distinguishing feature between

which are their antennae. Butterflies have slender, plain antennae with knobs at the tips: the antennae of the moths are pointed, and usually they are ribbed like feathers. Another easily detected difference lies in the size and shape of the body, that of a butterfly being small and slender, that of a moth large and thick. For the most part, butterflies are diurnal in their habits; moths nocturnal.

In China there are a great many species of both butterflies and moths, and anybody wishing to make a careful study of these insects could not do better than refer to Leeche's "Butterflies of China, Japan and Korea." For Shanghai enthusiasts there is a very good collection in the Museum of the Royal Asiatic Society, though many of the forms exhibited there have not yet been identified.

BUTTERFLIES.

It is an interesting fact that in North China one comes across numerous species of butterflies that are identical with, or at least very closely similar to, familiar species at home. The reason for this seems to lie in the fact that the faunas of Europe and North Asia, as far, even, as Eastern Siberia, and down through Manchuria into North China are one, that is to say, in many cases the same species, or very closely similar varieties of the same species, range from Great Britain right across Siberia to the Pacific Coast, and strangely enough, they have found their way into North China, where, on the northern fringes of the Yangtze Basin, they meet and mingle with an oriental fauna.

When one gets south of the Yangtze, new and even more beautiful species, almost tropical in their splendour, are met with, while in South China,—Fukien, Kwangtung and Kwangsi—tropical species predominate.

Perhaps the most beautiful and certainly the largest of the northern butterflies is a black swallow-tail, known to science as *Papilio maackii*, since it was first discovered by a collector named Maack in the valley of the Ussuri River in Manchuria. In this handsome species, in common with many other butterflies and moths, the female is larger than the male and somewhat differently coloured, so that to the uninitiated she might represent a distinct species. She is plain black, with crimson markings on the under wing. Her mate is black suffused with a brilliant,

metallic, emerald green, with very much less crimson on the lower wing. The species inhabits damp places, being most often found in the vicinity of streams or lakes. In Central and Southern China, its place is taken by a closely similar form, *P. paris*, in which the female has a broad white band across the upper wing.

One might well wonder why butterflies so often have these broad white markings on their wings, reasoning that such markings must make them even more conspicuous than they would be without them, and therefore an easier mark for hungry birds. But wait. Watch that large, dark butterfly. He is conspicuous enough as he flits through the air, but suddenly he disappears as he reaches a shady, moss-covered bank. All one sees is an irregular splash of white, but no butterfly! The reason is not far to seek, and recent investigations have brought it to light. If one takes a piece of black paper cut into the form of a butterfly, and lays it on a flat surface of green baize, it is very conspicuous. But take a disc of white paper and lay that upon the black butterfly, and immediately the latter ceases to be noticeable, and only by more careful observation will one detect it. The white disc has become the dominant object in view and, by over-stimulating the nerve endings of the retina upon which its image falls, overpowers the reaction of those not affected. Thus a bright splash of white upon a butterfly is really a very clever bit of "camouflage."

It is quite impossible here to run over the list of the numerous species of butterflies that may be encountered in the garden in China, and even in selecting one or two for special mention, the writer has considerable difficulty in deciding between their respective merits. There is no particular reason why one should be chosen more than another. A very beautiful species is one of the smaller swallow-tails, *Papilio telamon*, whose general colour is cream-white with irregular black bars and dots on the wings, and some pretty scarlet and blue markings on the lower pair. It has long, slender "tails." This form is widely distributed over the whole of North China. When first discovered by a member of Lord Macartney's mission to Peking, it was considered a very rare species.

A fascinating study for those who care for such things, is the complete life histories of butterflies. The caterpillars and



THE ATLAS MOTH (*Saturnia atlas*)

chrysalids of but few of the numerous species to be found in these parts are known, and the only way in which they can become known is for the student of entomology to gather the eggs, hatch them out, and rear the caterpillars, and finally to note the form of each chrysalis and the species of butterfly that emerges from it. And, incidentally, there is no better way of securing really good specimens of these delightful insects. Shallow boxes, with gauze or mosquito-netting coverings, are the only gear needed, while the daily changing of the leaves upon which the grubs feed, so that the latter are always supplied with plenty of fresh food, is all the attention required. The seeker for butterflies' eggs should look on leaves of plants, mostly on the under surface, or on twigs, and usually they will be found in little clusters, oblong in shape and set in an upright position. Moths' eggs are mostly spherical and are usually more or less scattered over the leaf surface to which they adhere. Spring and early summer are the best times of the year in which to seek for the eggs of these insects. Chrysalids may be sought in the autumn, and kept over till the spring, when the insects will catch out, and lay their eggs.

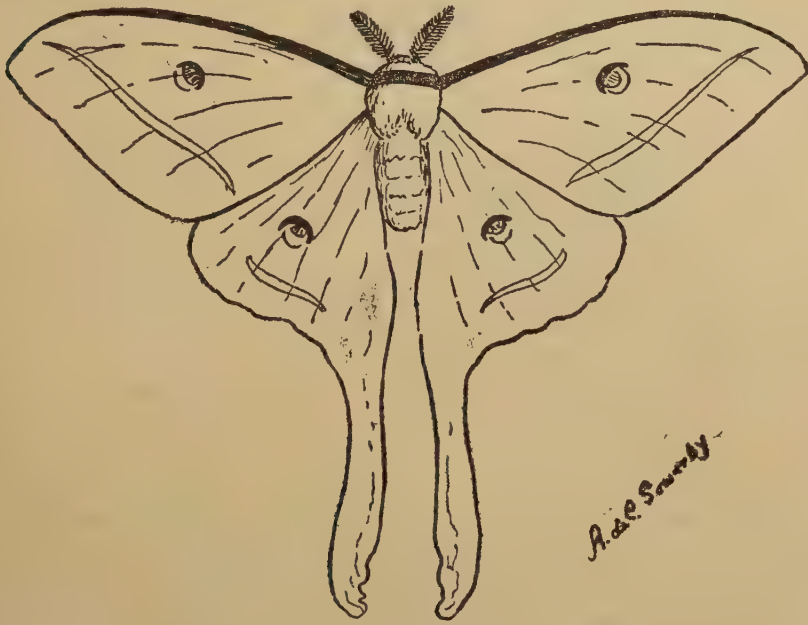
MOTHS.

While the chief attraction of butterflies lies in their beauty of form and colour, that of moths is to be found more in their habits and life histories. Of course, one does not wish to suggest that moths are not beautiful: many forms even surpass the most gorgeous butterflies, but, taking them as a group, they are more sombre in colour, soft, rich browns, greys and yellows predominating.

The honours for beauty might be considered to be evenly divided between the Atlas moth and the luna moth—certainly these two transcend any of their kith and kin in sheer magnificence. The Atlas moth (*Saturnia atlas*) is by far the largest species in the country. The female has a wing-span of nine inches, the male being a little smaller. The general colour scheme of this gorgeous moth is a rich reddish-brown, the wings being beautifully marked with cream, black and white. There is a triangular, transparent patch on each of the four wings. Whether this handsome moth ranges as far north as Shanghai, seems doubtful, but it is comparatively common in Fukien Pro-

vince. It belongs to a family of moth (*Saturniidae*) which are known in America as the silk-moths. The caterpillar spins a cocoon, fastening it to the under side of the limb of some large tree, where, owing to its colouring, it is admirably hidden.

The luna moth (*Attacus selene*) is an insect of extraordinary beauty. Of a considerable size, it has the lower wings prolonged into long "tails," while its colouring is a delicate pale green, the edges of the wings being marked with purple-brown, and each wing having a conspicuous "eye", or semi-ocellated spot. In America its place is taken by a closely similar species called *A. luna*.



THE CHINESE LUNA MOTH (*Attacus selene*)

Another form of *Attacus* found in China is the Cynthia moth (*A. cynthia*) which is of a biscuit brown colour, with beautiful markings, but has no "tails." In these large forms the proboscis is but poorly developed.

Next to these handsome species in point of beauty come the hawk-moths, family *Sphingidae*, which differ from the foregoing in having long slender wings, and larger, more tapering bodies. The hawk-moths are rapid and powerful flyers, with well developed eyes and proboscis, and they are purely nocturnal in their

habits, with the exception of the humming bird hawk moth. The largest, and probably the most interesting of the group is the death's head (*Acherontia*), the form inhabiting China being somewhat different from the British species. It is a very handsome moth, with dark grey-brown colouring and deep yellow abdomen and under wings, the back of the thorax being marked with the characteristic death-mask, which gives the insect its name.

Another large species is the convolvulus hawk-moth (*Sphinx convolvuli*). This moth presents a wonderful example of Nature's "camouflage," for its colouring is grey, beautifully mottled and straited with black or darker markings, so that it exactly resembles the bark of trees, or the irregular surfaces of lichen-covered rocks. In this case Nature has adopted a very different method for con-

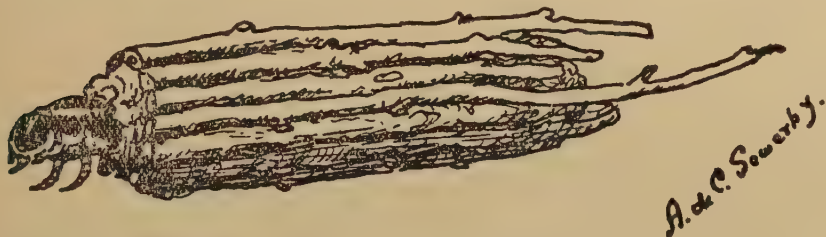


THE DEATH'S-HEAD MOTH (*Acherontia*)

cealment from the "dazzle" effect noticed in that of the white-barred butterfly. In the convolvulus hawk-moth the continuity of outline is broken, and consequently the form disguised is obliterated by dark markings which continue on to the body the markings of the ground surface on which the moth rests.

While on the subject of "camouflage", yet another means adopted by Nature of protecting her creatures may be mentioned. This is by mimicry. Certain edible insects have, through evolution, come to resemble certain other noxious or disagreeably tasting ones, so that birds searching for food avoid them. An example of this amongst the moths to be found in China is a species known to science as *Zeuzera coffea*, which bears a remarkable resemblance to a bee or wasp. Its wings are transparent, and very much the shape of those in the *Hymenoptera*.

The humming-bird hawk-moths form a very interesting group within the family *Sphingidæ*. They may be seen any bright day hovering over the flower beds, darting with extraordinary rapidity from bloom to bloom, hanging poised and motionless over each as the long proboscis feels its way from elfin cup to elfin cup, seeking the sweet nectar that is their food as well as that of the gods. The resemblance they bear to a humming-bird is really remarkable. Understandable in regard to the species that inhabit the Americas—and their number is considerable—there seems to be no reason for this type of “camouflage” amongst the forms that inhabit Asia or Europe, since there are no humbird-birds in these continents. One wonders, almost, whether the whole group is not American in its origin, the Eurasian species having found their way to the Old World without changing their form to any appreciable extent. As a matter of fact the local form is not unlike some of the larger bees



THE CATERPILLAR OF THE PSYCHE MOTH IN ITS HOME OF TWIGS

or other members of the *Hymenoptera*. One can never watch a humming-bird hawk-moth without being faced once more by the, as yet, unanswered question. Does it or does it not fly backward? Certainly it appears to do so, but the mere mechanics of the question seem to preclude such a possibility; and one is forced to conclude that either we are woefully deficient in our knowledge of the mechanics of flight, or else that the insect does not really *fly* backward but *falls* backward, the action being so rapid as to deceive the human eye. In any case, this is a problem worth investigation.

A very interesting moth is *Abraxus ulmata*, commonly called the currant moth. It invariably inhabits currant bushes or closely related plants, and may easily be recognized by its variegated black and white colouring. In this species there are several broods during the summer, the members of each brood varying in size from

those of the preceding one. The maximum size is attained early in the summer, the minimum in the last brood in the autumn.

Amongst the most beautiful of the smaller moths are the satin moths (*Leucoma salicis*) and the ermine moths (*Spilosoma*). Of these the former is a pure white species, while the members of the latter genus are white often spotted with fine black dots on the wings, and with crimson or yellow abdomens barred black.

A pretty little moth, called *Hyponomenta minnellus*, has the upper wings satin-white and the lower ones grey. The caterpillars occur in masses, and when they pupate spin webs round clusters of leaves forming regular nests.

Occasionally one may come across a brown moth, which is, apparently, the wild prototype of the cultivated silk-worm moth. The latter is white. In the wild species the caterpillar exactly resembles a twig, and, when danger threatens, it stretches its body out and, remaining rigid, perfects the illusion. The wild silkworm frequents scrub-oak, and is a native of Shantung, the silk it produces being known as Tussore.*

Sericulture is making rapid strides in China, and there are big movements afoot to establish extensive mulberry plantations and to introduce good breeds of worms in such provinces as Fukien and Chekiang. Experimental stations should be established all over the country in order to discover exactly which breeds of worm thrive in each locality, and what form of plant food yields the best results.

By far the most interesting of all the moths to be found in the garden is the *Psyche* moth. It is difficult to understand why it received this name, for beauty is by no means its strong point. The male is passable, but the female, wingless and bare of the beautiful covering of velvet that most moths enjoy, is a poor, ugly creature. It is the caterpillar, however, that most attracts one's attention, since its habits are remarkable. It does the same sort of thing as the caddis worm, only its home is on the prickly wild nature. It is ilke shan, a hill, or hills, which, used as a prefix

*The word tussore, or tussur, is believed to be derived from the Hindustani *tasar*, a shuttle. There are several species of moth from which wild silk may be obtained, most of them being large, handsome species. Indeed, they are closely related to the Atlas moth (*Saturnia atlas*) already mentioned. The caterpillars of this whole group of moths spin very strong cocoons. The moth from which tussore silk is derived has been introduced into the hills of South Manchuria where it thrives on bushes of scrub oak with which the hills are covered. Large quantities of raw silk are shipped to Shantung.

branches of the juniper or other coniferous shrub instead of under water. Taking small twigs, each cut to a definite length, it binds them with silken thread to form a cylindrical tube, a covering for its own soft body. This snug home is lined within with silk, and is very strong, which makes it a sure protection against birds for the helpless creature within. In an experimental mood, the writer took some of these cases and slit them with a scissors, taking care not to damage the grub within. Immediately the latter got busy, and within an hour or so had repaired their damaged homes so well that it was impossible to detect where they had been split. When ready to pupate, the grub of the Psyche moth binds its home tightly to a twig, then closes the mouth. The period of rest over, the perfect insect—or imperfect, if it be a female—emerges through a hole cut at the end of the cylinder opposite to the original opening.

A much larger form of Psyche moth caterpillar is to be found on the larger deciduous trees. In this case the home is made of leaves bound together rather than twigs.

There is one extremely interesting moth that looks exactly like a dead leaf when its wings are folded. It is a rather large species. Strangely enough, the under wings in this species are a bright orange-yellow, and the insect, when flying, is very conspicuous. Here is another clever "camouflage" ruse of Nature. The bright colour of the insect's under wings, as it flies, catches the eye of a marauding bird, which immediately gives chase. The bird's faculties are concentrated upon the bright colour. Suddenly the moth settles on a branch or twig, and the bright colour immediately vanishes, as it is covered over by the upper wings. As far as the bird is concerned the object of chase—the bright orange-yellow under wings—has vanished into thin air, and only a dead leaf hanging to a twig remains.

Owing to the rapacious nature of their caterpillars, when it comes to the foliage of the plants upon which they live, moths and butterflies form an undoubted pest to gardeners, so that it is comforting to know that they have a great many enemies. Chief amongst these, aside from birds, are the various species of *Ichneumon* wasps. The method of the latter in preying upon caterpillars is interesting. The adult female lays her eggs, either in the eggs of the butterfly or moth, or else actually in the caterpillars themselves. In due course, these hatch out into tiny grubs, and proceed



LEAF-MOTH, FLYING AND RESTING

to eat away the interior juicy tissues of their host, though without causing death in the latter till such time as they themselves are ready to pupate. They then bore their way through the body walls of the caterpillar they infest, and spin a cocoon, leaving their hapless victim a lifeless, withered thing.

CHAPTER XXIX.

THE "STRAIGHT WINGS."

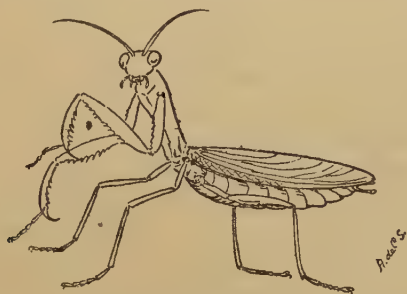
As spring approaches many members of the foreign community in China begin to think about their gardens again, so that we may continue the study of insects that inhabit gardens in China without seeming irrelevant, and forget for a while the politics of this strife-ridden country; reports of bandits, and police raids; agitations about pure milk supply, and other subjects that go to fill our daily newspapers.

In the preceding chapters of this book we have dealt with various orders of the great class *Insecta*—butterflies, moths, beetles and bugs—and now we may take a look at the so-called straight wings, or *Orthoptera*, which order includes locusts, grasshoppers, crickets, mantises and cockroaches. Taking the order as a whole it is not so well represented in a well kept garden as such insects as beetles, butterflies and moths, for the reason that many of its members like a greater luxuriance of vegetation than is usually allowed to exist there. Long grass, thick, clustering bushes, a tangle of undergrowth, these are what the grasshoppers and mantises love, while crickets, boring into the earth and preferring more or less damp places, are usually disturbed beyond endurance by the gardener's spade. Nevertheless, from time to time members of this interesting group of insects make their appearance, though it might be suggested that this appearance is the first sign that the garden is not being properly kept.

An exception must be made in the case of the praying mantis, whose food consists of other insects, and whose habitat is the tops of bushes and flowering plants. Hither other insects are attracted by the honey-laden blossoms, and this draws it into the gardens, for a plentiful food supply awaits it.

Undoubtedly the praying mantis is the most common member of the *Orthoptera* to be encountered in gardens, which being the case, we may begin with this remarkable insect in our discussion of the group. The common mantis of China closely

resembles the European species. It appears to have two colour phases (unless indeed two actual forms occur), one of which is bright green, and the other buff brown. In each case, however, the back of the abdomen is a rich purple colour, only displayed when the insect opens its gauzy wings to fly or during combat. The praying mantis derives its name from its peculiar habit of sitting erect and waving in the air its anterior limbs, which are in the form of sub-chelate pincers, giving the insect an almost ludicrous resemblance to a suppliant in prayer. "Mantis" means "prophet," the name having been given to this insect by the Ancient Grecians, who saw in its posture and gestures a resemblance to those of their priests and priestesses. These anterior legs are armed with rows of sharp spines, the last main joint bending down on the one before it just as the blade of a penknife shuts down on the handle. It is this formation in



THE PRAYING MANTIS

pincer limbs that is known as sub-chelate, the chelate form being that of the crab, which more resembles true pincers in its action. The pincer limbs of the mantis assist the insect greatly in climbing about the bushes. Another peculiarity of the mantis is the really remarkable way in which it can move its head. In no other insect is this member so free in its movements, and the effect upon the observer, as the mantis turns its head to take note of its surroundings, is almost uncanny. It gives the insect the appearance of having an intelligence far beyond that which its modicum of cerebral matter warrants. The greatest amusement can be derived from a mantis by placing it on a table and watching its antics as it turns first to one and then to another of those watching it, making short dashes at the onlookers, it would almost seem, in a playful spirit. It takes considerable self

control on the part of an observer, who happens to have his face close to the table, to withstand what appears to be a vicious onslaught by this uncanny insect, the effect of its wildly waving claws being usually too much for his nerves.

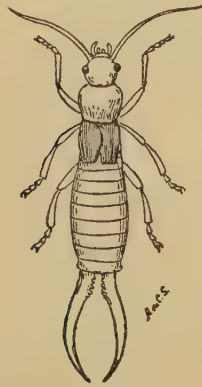
The mantis is a bloodthirsty insect, and is endowed with extraordinary agility, and, considering its fragile appearance and delicate frame, is unusually powerful. I have frequently watched one of these insects seize a moth double its weight and size with its fore-claws and commence devouring it, utterly regardless of its desperate struggles to escape. The agility and strength of the mantis may be realised when it is considered how it stands perched on the top of a bush, watching its opportunity to pounce upon some unsuspecting insect, or to seize it hovering in mid-air regardless of its size. Its temerity is extraordinary. Its method of dealing with large insects is interesting in that the creature has learned by experience that the most vulnerable part is the back of the neck, where its powerful jaws may puncture the main nerve, thus soon paralyzing its prey. In tropical countries mantises assume all sorts of brilliant colours in order to deceive other insects; some species, which inhabit certain flowering bushes and trees, actually resemble the blossoms in shape and colour to such a degree of perfection that other insects will mistake them for the flowers themselves, and so fall an easy prey. In South China there are one or two of these aberrant forms, one of which, *Mantis bicornis*, is very long and slender, while the other *Empusa flabellicornis*, is remarkable for its very broad abdomen, long and slender thorax, and brilliant colours. In this connection it may be mentioned that the common form itself closely resembles a leaf and is not easily discernible on the background it chooses for itself.

The observant gardener may often have noticed a peculiar little brown pod of an inch or so in length adhering to the branch of some bush. This is the mantis' egg pod, and consists of a fibrous-looking material enclosing series of cells, in which the larvæ of the insect may be found. This egg case is made from secretions of the abdomen of the female by means of two paddle-like appendages, which beat up the sticky matter into a sort of foam, in which the egg is deposited. Layer after layer of eggs is laid, one above the other. In due course, the larvæ find

their way out through small holes at the tops of these cells, the uppermost layer escaping first, so that successive broods make their appearance periodically, and soon scatter far and wide over the neighbouring bushes. They are small, wingless creatures displaying, however, the voracious tendencies of their parents. They grow very rapidly, and by the middle of the season have developed wings, and by the end are fully matured. It is then that the egg pods are deposited on the branches, where they remain with their precious contents throughout the winter. Certain species of birds are particularly fond of the mantis larva as food, and attack these pods, tearing them to pieces in order to secure the delicate morsels within. First amongst these is the little crow-tit (*Suthora webbiana*). This is a small bird with a little, short, thick beak, and long tail. It is a pretty brown colour with a tendency to rufus, especially in the male. Large flocks may be seen during the winter passing through the gardens on their diligent search for the egg pods of the mantis and any other insect food that may come their way.

It is probable that the mantis is the most useful of all our garden insects, since it preys upon other insects which are noxious. Nevertheless, by interfering with species that perform the function of fertilizing flowers, it may do a certain amount of harm. This, however, is in no way commensurate with the good it does, so that on the whole the mantis should be encouraged by all gardeners. To those who derive amusement from such sport (if it can be called such) a fight between two mantises is a thing to be remembered. Pugnacious to a degree, the two antagonists circle round each other much as do pugilists in the ring, watching for an opening. Anon one will make a feint, which the other cleverly parries. They keep facing each other, their antennæ waving, and their claws held up ready for instant use. Presently one makes a sudden pounce and, if successful, seizes some portion of the other's anatomy in its cruel chelæ, possibly lopping off a limb, and in return, receiving punishment from its opponent. The cruel fight goes on until one or the other gains the ascendancy, when, without further ado, he makes a meal of the vanquished. It may here be mentioned that the female mantis is in the habit of devouring her mate as is the manner of certain spiders, a thing made possible by the smaller size of the male.

The mantis, together with the leaf-insects and stick-insects (*Phasmatidæ*), the cockroaches (*Blattidæ*), and the earwigs (*Forficulidæ*), belong to a tribe that is known as *Cursoria*, or runners, owing to the fact that they do not possess the long, jumping legs of the grasshoppers and locusts, which belong to a tribe called *Saltatoria*, or jumpers. Everybody is familiar with the earwig, which is another very common member of the *Orthoptera* to be found in gardens. Unlike the mantis the earwig is said to be a very noxious insect, and to do considerable damage to young plants upon which it feeds. The main points of difference between the earwig and other members of the *Orthoptera* lie in the fact that the posterior pair of wings, which the insect uses in flying, when not in use are folded up and



THE EARWIG



THE BALL COCKROACH

tucked away under the anterior pair (*elytra*), much as in the beetles, and that the hindmost segment of the abdomen is armed with powerful pincers, which the insect uses in offence and defence, by curling the abdomen over the body. These pincers are much larger in the male than in the female, which might suggest that they are used in fights between males of the same species. Earwigs are to be found under stones and old logs, and only come out into the open at night. A very favourite method of destroying them is to place upturned flower pots on the ends of sticks stuck into the ground amongst the flowers, the earwigs finding shelter in these pots, and falling an easy prey to the gardener. The common earwig of China is

not unlike its cousin of Europe though, it may be remarked, several forms are to be found in this country.

Though cockroaches are not usually associated in the minds of the public with gardens, it must not be assumed that they are not to be found in such localities. As a matter of fact, certain forms of cockroaches are only to be found in open country, and in gardens, and not in houses. The *Blattidæ*, as the cockroach family is called, are a very widely distributed group of insects, and it may come as a surprise to some to know that they belong to the same order as grasshoppers and mantises and not, as is popularly supposed, to the beetles. The members of one of the common forms found in houses, especially in cellars, are generally known as blackbeetles, which doubtless accounts for the popular belief that cockroaches belong to the *Coleoptera*. An examination of their general shape, and especially the form and texture of the wings, will soon convince the investigator of his error. In China some very interesting forms of cockroaches occur. One of these, a very large species, has developed the habit of curling up into a ball, much as in the pill bugs, relations of the woodlice. These large cockroaches are to be found under stones and old logs, and their appearance is far from attractive, as they are loathsome looking insects. They are quite harmless, however, and do no damage in a garden, so that their presence need cause no concern to the horticulturist.

While on the subject of cockroaches, the good housewife may be advised that the only sure way of getting rid of these insects is to starve them out by leaving nothing about in the way of food. This, it must be admitted, is a well nigh hopeless task in such a country as China, but a great deal may be done by seeing that all foodstuff is carefully put away in closed receptacles.

The very large species, which is commonly known in Shanghai as the flying cockroach, but elsewhere as the American cockroach (*Periplaneta americana*), and which makes its appearance at the festive board on summer evenings as an uninvited guest, is of world-wide distribution, having been carried from place to place over the globe on sailing ships and steamers. Its original home is thought to be America, though there is some doubt about this. This insect is an interesting example of the inter-relationship between man and the lower world, whereby a member of the latter has profited by association with the

human species. One must admit that mankind does not appreciate the honour, and would infinitely prefer the insect's room to its presence. The same applies to the common cockroach (*P. orientalis*) found in houses throughout the world. This form is supposed to have originated in the East and to have been distributed by mankind.

In Fukien Province and southward a species of stick-insect (*Bacillus*) is very common. This is one of the wingless forms, and it is of a dull grey-brown colour, resembling a dried twig of the cryptomeria or pine upon which it lives. Leaf-insects (*Phyllium*) also occur in these parts, but are not very common. The resemblance of stick-insects to twigs and leaf-insects to leaves is really astounding. In passing it may be mentioned that in Fukien a remarkable grasshopper exactly resembling a dried twig occurs, usually clinging to stone walls or rocks.

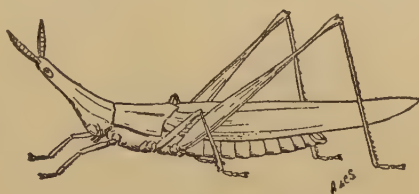
By far the largest number of orthopterous insects belong to the *Saltatoria*, and are all characterized by the great development of the hindermost pair of limbs. To this tribe belong the locusts, the grasshoppers, the katy-dids, the crickets and the molecricket, the last mentioned, however, having but poorly developed hind legs in comparison with the others. Of these, the molecricket (*Gryllotalpa chinensis*) spends the greater part of its life burrowing about underground, where it is reputed to do considerable damage to the roots of plants. Since, however, its food consists of grubs and other insects, it is problematical whether the harm it does is not outweighed by the good. However this may be, gardeners usually destroy molecrickets on sight. Chinese particularly dislike them. In fairness to the molecricket it should be said that the damage attributed to it may be due more to the grubs of beetles, upon which it feeds, the fact that it is found in proximity to damaged roots having earned for it an evil reputation. This insect may easily be recognized by its greatly developed anterior limbs, which resemble the fore-paws of the mole, and are used for the same purpose. The insect itself is of a pretty brown colour, the surface of the body having a velvety appearance. It has a pointed head, and long pointed posterior, or flying, wings, the anterior pair being short and broad. When running about upon the ground it bears some resemblance to a small mouse. Very often insects of this species fly into the house at night, being attracted by the light, when they cause considerable disturbance,

especially amongst the ladies present. They are absolutely harmless, however, and need cause no alarm in a drawing-room. It is a very difficult thing to get rid of these insects, but since they make burrows, the gardener should keep his eye open for the mouths of these holes, down which water may be pured. This has the effect of sometimes driving the insect away. The eggs are laid in large chambers underground, and there the young are hatched and remain for some time, so that by drowning the burrow these also may be destroyed. A word in warning should be given in the case of the molecricket, for upon closer investigation it may turn out that this insect is really a friend and not a foe.

No antagonism need be harboured against true crickets (*Gryllidæ*) which are altogether delightful insects. There are several species to be found in China, one of which, a large black form, is a very handsome fellow. The common form found in the country may be called the field cricket, the fully adult insect



THE CHINESE MOLECRICKET
(*Gryllotalpa chinensis*)



Truxalis chinensis

being of a blackish colour. The crickets are an interesting group of insects in that they have very fine vocal powers, if the noise made by the vibration of their wings against each other may be correctly called a voice. Everybody has heard of the fights which take place between crickets, apparently owing to rivalry in the matter of song-production. It is really remarkable that wherever singers are gathered together, whether they be bird, beast, insect, or man, rivalry and jealousy are rife. No one knows this better than the much to be pitied choirmaster, while anybody who has had much to do with song birds will also appreciate this fact. The crickets may be recognized by their strong mandibles, very long, whip-like antennæ, and rather thickset bodies. They are creatures of retiring habits, living under stones, in holes, and in cracks in the earth, whence their shrill but rather sweet notes emanate, baffling the listener as to their point of origin. It is almost impossible to trace the whereabouts of a cricket from

its song, for whichever way the head is turned, the sound seems to come from some other direction. The Chinese, especially in the north, are very keen lovers of the sport of cricket fighting, each enthusiast owning one or more of these little insects, which he carries carefully in a small case in his sash, and which he never loses an opportunity of pitting against the pet of some other devotee of the sport. As each individual cricket conquers its opponent, its value is enhanced, and it scores points. There comes a time when open contests are arranged, and a table is set up in the market square, whereon a bowl is placed. Owners of crickets enter their pets in the contest which proceeds merrily throughout the day. Two crickets are placed in the bowl and there they remain till one or the other is vanquished. The winner then has to meet some other challenger, and so the game goes on till there remains only one conquering cricket, which becomes the hero of the day. Considerable betting takes place, and cricket fighting contests form of the chief sporting features of a Chinese community in the autumn.

Everybody knows the little house cricket (*Gryllus domesticus*), whose home is the hearth, and whose piercing but sweet note enlivens our weary winter evenings.

Closely related to the crickets come the grasshoppers (*Locustidæ*). Contrary to what one might suppose the locust does not belong to this family but to the *Acrididæ*. This is one of the anomalies which one frequently comes across in the popular and scientific nomenclature of animals, and it owes its existence to confusion in the writings of earlier naturalists. The grasshoppers are characterized by their long, whip-like antennæ, and four jointed tarsi (foot), in which they differ from the *Acrididæ* wherein the antennæ are usually short, and the tarsi three jointed. To this family belong the large predacious grasshopper (*Locusta*), of which the Chinese are so fond, and the males of which have the power of making a noise somewhat similar to that of the cicada, by the vibration one over the other of their wings. These insects are to be found on bushes where they keep up an incessant singing, apparently for the purpose of attracting the females. As in other true grasshoppers the organs of hearing are placed in the fore-legs. The food of this species consists mainly of other insects, the grasshopper lying in wait for, and pouncing upon, the prey somewhat after the manner of

the mantis but far more clumsily. Like the mantis, it inflicts the fatal wound on the back of the neck. Another member of this family, which is fairly common in China, has very large leaf-like wings, while yet others more closely resemble the true locusts in having long, slender wings. The females of the whole family are armed with long, scabbard-like ovipositors, with which they pierce the ground where they deposit their eggs about one inch below the surface.

A very interesting species has recently been described from Fukien Province. It is known as *Atlanticus palpalis*, Rehn & Hebard. Its main point of interest is that it belongs to a genus which had not previously been found in the Old World, but was confined to the Eastern and Central parts of the United States and adjacent areas in Canada. This is an extraordinary distribution, but is somewhat paralleled in the case of the alligators, which are only found in the lower Yangtze Basin and the



THE CHINESE KATY-DID
(*Atlanticus palpalis*)



THE CHINESE MIGRATORY LOCUST
(*Pachytylus cinerascens*)

Mississippi, and it shows very clearly that at some distant date South-eastern China and America were in some way faunistically connected. So far, only the female of this remarkable species has been discovered. It is a rather large form, somewhat resembling the American katy-did. A single specimen was sent from Yengpingfu, Fukien Province, to the American Museum of Natural History by Mr. H. R. Caldwell, and as far as I am aware, only one other specimen is known, namely one in the collection of Professor C. R. Kellogg of Fukien Christian University, which was taken in the mountains near Foochow. The distribution of this species is thus quite unknown, but, judging from that of the fauna of South-eastern China, it will probably be found to range almost up to Shanghai, possibly to include this area. Its colour is brownish with darker markings on the thorax and legs. The antennæ are very long, while its main distinguish-

ing feature is the unusual length of the distal maxillary palpal joint.

Yet another very remarkable member of this main group is to be found inhabiting caves in China. In this species, of the name of which I am unaware, the body is very soft, the legs long and slender, and the antennæ extremely long and whip-like. In the female the abdomen is large and rounded, turning downwards, while in the male it is short and upturned. Both are wingless. I have come across them in old caves, and mine shafts in the mountains of North China, and also in caves in Fukien Province, but have had very poor success in trying to preserve them for identification, owing to the extreme softness of their bodies. They crawl and hop about on the surface of the rocks, and at the slightest alarm retire into the crannies. Their food must consist of the excreta of bats, since apparently there is nothing else available. I have not been able to ascertain whether they are gifted with the power of sight, but would suppose them to be blind, their powers of perception being confined mainly to their enormous antennæ. Such loathsome looking insects, with their soft bodies and dirty whitish colour, materially add to the horrors a bat cave.

The last family with which we have to deal as already stated is known as the *Acrididæ*, and includes the locusts, and what may be called for want of a better name, grasshoppers. The latter are not very prevalent in gardens, preferring the open country, but, when present, need cause no alarm, since they do practically no harm. China boasts a large number of species which are to be found in all localities—open, stony river beds, sandy beaches, barren hillsides, marshes and meadow lands. In these species the chirping noise is made by rubbing the long hind legs up and down against the outer edge of the anterior wings, and it sounds like the rustling of leaves rather than the shrill, piercing note of the cricket, and the grinding of the true grasshoppers. Many of them have brightly coloured posterior or flying wings, which fold fan-like under the dull-coloured anterior wings. In the members of this family the auditory organs are placed one on each side of the first abdominal segment, immediately behind the thorax.

Within this family there is one very remarkable group of grasshoppers in which the forehead is greatly elongated anterior-

ally, while the whole body is long and slender; and when the insect is perched upon a grass stem it bears a close resemblance to a grass blade. Here again two colour phases exist, one of which is bright green and the other brown, exactly as in the praying mantis, and, as in the mantis, the abdomen is of a rich purple colour. These peculiar grasshoppers, known to science as *Truxalis chinensis*, are extremely common in grass fields and not infrequently find their way into our gardens, where, however, they do no harm.

The only true pest in this group is the locust, which occurs in Central and Eastern China, ranging as far north as the borders of Manchuria. Even so, it is only when they multiply, which they occasionally do, to such an extent as to become a plague that they give cause for alarm. I well remember one such visitation taking place in Northeastern Chihli. Where the insects came from it was never discovered, but suddenly they began to pass over the Tientsin Settlement in clouds, and for three days the air was full of them. They continued in a northeasterly direction, eating up everything green in the country as they went, and doing an enormous amount of damage to the crops. During the summer in question they were reported from numerous areas in Chihli and Honan provinces. I secured specimens of these insects, and sent them to the Smithsonian Institution for identification, where they were found to belong to the species *Pachytylus cinerascens*, closely related to *P. migratorius* which ranges from Southern Europe to Central Asia. Though they did so much damage to the crops they were not altogether useless, since the Chinese are very fond of these insects as food, and they provided a fat feast for the natives. I also tried them in the various ways in which they are cooked, and found them quite palatable though somewhat nauseating. They may be fried in oil or dry-roasted, but in both cases the wings and legs must be taken off. The Chinese also eat the ordinary field grasshoppers, which, in the late autumn, are very fat. It is no uncommon thing in the vicinity of Tientsin to see the natives out all over the fields "swatting" grasshoppers, which they take home and fry in oil. Boatloads of these insects, contained in large baskets, are brought in from the marshes and sold in the local markets.

It is not certain whether or not our locust is the same as that mentioned in the Bible. Some consider the North African

form, *Schistocera peregrina*, to be the one referred to in biblical writings. It is probable, however, that *P. migratorius* was the form mentioned in some instances.

It is only under certain very favourable conditions that the locusts multiply sufficiently to become a plague. They are then driven by hunger to seek food outside the area in which they are born. First begins a march of the larvæ, which differ from the adult insect mainly in the undeveloped state of their wings. Later, after several moults (usually about six from the time of hatching), the perfect insects with fully developed wings appear, when the migration is greatly accelerated and becomes more scattered and wide spread, usually following the general direction of the prevailing winds. A really bad swarm leaves nothing green in its wake, and even the barks of trees are eaten, so that every living plant is destroyed, and the land through which the army passes is utterly laid waste. Epidemics of locusts are commonest in Central China, and it is only occasionally that they get so far north as the Tientsin district.

Of the non-migratory grasshoppers or locusts there are some very beautiful forms, nearly all being characterized by the bright colour of their flying wings, which may be red, pink, pale blue or merely green. All are well adapted in colour and markings to harmonize with their surroundings, and it is only when in flight that they show the conspicuous colouring of their under wings. The cause for this has already been explained in connexion with some moths, which resemble leaves, but have bright under wings. It deceives birds, which chase the insects when in flight, only to lose sight of them the more completely when the latter fold their bright wings away under the dull-coloured covering ones.

CHAPTER XXX.

NERVE-WINGED INSECTS.

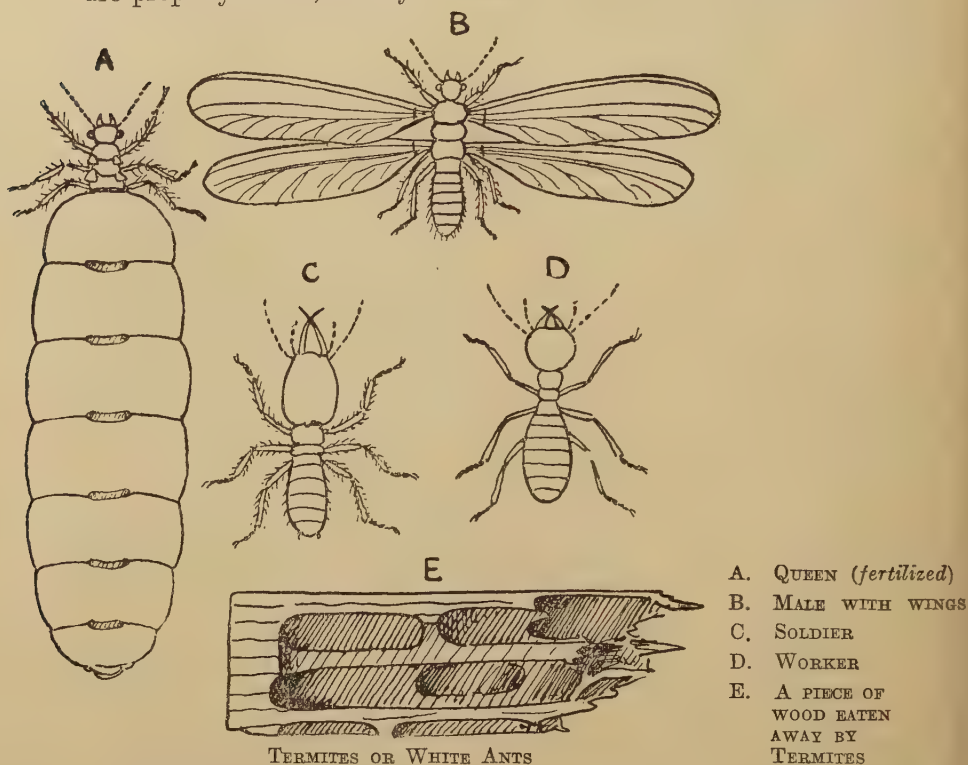
We now come to a group of insects, the members of which in their delicate shapes and graceful forms surpass those of all others. These are the nerve-winged insects, in which the wings are usually very large and gauzy-looking, covered with a network of delicate veins.

In its strict sense the order *Neuroptera* is now restricted to include only a limited number of the insects that formerly went to comprise it. These are the ant-lions (*Myrmeleon*), the aphis-lion (*Hemerobius*), the lace-wings (*Chrysopa*) and the alder-flies (*Sialis*). The various other insects that used to be included in the order *Neuroptera* are now placed in a number of different orders of their own, but we may still deal with the whole group together because of the past association of its members. The orders mentioned above are :—

- 1.—The *Isoptera*, which includes the termites or white ants.
- 2.—The *Paraneuroptera*, which includes the dragonflies.
- 3.—The *Ephemeroptera*, including the day-flies and mayflies.
- 4.—The *Thysanoptera*, or corn-flies.
- 5.—The *Trichoptera*, or caddis-flies.
- 6.—The *Neuroptera* (*Sensu stricto*) including ant-lions, aphis-lions, lace-wings, and alder-flies.

It may come as a surprise to many readers to learn that the white ants, whose ravages are such a source of trouble to builders and contractors in the vicinity of Shanghai, and, to a greater extent, in more tropical climes, are really not ants at all but belong to a group of insects with close affinities to, say, the dragonflies, but which have assumed a social organization and habits very similar to those of the true ants, which, by the way, belong to the same order as bees, and wasps, *Hymenoptera*. In such countries as Africa some forms of white ants build themselves enormous nests extending above the ground almost like buildings, while

others make nests in trees, which are connected by covered-in runways with other nests below ground. The species that inhabit China from about the latitude of Shanghai southwards seldom build nests above ground—though occasionally one may be found—their nests occurring mainly at varying depths in the earth, within the trunks of dead trees, or in the woodwork of houses. In regard to the social organization of white ants, or termites as they are properly called, it may be noted that there are several different



forms, just as there with the true ants. These are the males, females, soldiers, and workers, the first being known as kings, the second, when in breeding state, as queens: unfertilized females may also be found, so that in reality a termitarium, as a community of white ants is called, may contain five distinct types of individuals. The fertilized queen is usually enclosed within a cell made of hardened mud or masticated wood, and there she remains throughout her life, the eggs that she lays

being carried away by the workers through small holes in the wall of the cell. The abdomen of a fertilized queen is enormously distended, so that her total length is four or five times that of an ordinary female, and the girth of her abdomen very considerable. At this stage she looks somewhat like a large, white maggot, only to be distinguished by the thorax, legs and head, which remain at the anterior portion of the swollen body. Should any accident overtake the queen, one of her unfertilized sisters may take her place. It seems that amongst the white ants certain females are kept in reserve, so to speak, for just this contingency. They differ from the true queen in that they never develop wings. They are known as complementary reserve queens, and as soon as they take the place of the defunct true queen are known as substitute queens.

Both king and queen termites, in their initial stages, are first of all provided with large, gauzy wings, which have very simple neurulation, and which break off at a certain junction near the base after they have served their purpose of carrying their owners to some distant part, where a new colony may be started. The soldiers and workers and reserve females, as well as certain amongst the males, never have wings at any stage of their existence. In the males and females the three parts of the thorax are more or less divided and of equal size, while the head is comparatively small. In the soldier the head is as large as the whole of the rest of the body, and there are very powerful pincer jaws, while in the worker the head is larger than in the sexual forms, but not so large as in the soldier, its jaws being but slightly smaller than those of the latter. The three parts of the thorax are much narrower than the abdomen. In soldiers and workers there are no eyes, though these organs are present in a well developed state in the sexual insects.

Anybody who has had anything to do with buildings in this part of China and further South will be familiar with the way white ants will destroy woodwork. They very seldom show any traces from the exterior, since they keep entirely within the structure that they attack, and it is only when this has been drilled through and through, and rendered comparatively rotten that its collapse reveals the presence of the pest. White ants burrow down to considerable depths in the ground, where, as a rule, the fertilized queen or queens, as the case may be, occur. Their food—

the woody fibres that the workers gather above ground—is carried down by means of innumerable tunnels.

The main enemy of the white ant is the remarkable creature known as the pangolin or scaly ant-eater (*Manis*), the enormous claws of whose front feet enable it to burrow down to the underground nests. This animal is provided with a very long tongue, with which it explores the galleries, licking up the ants as it finds them. There are a number of genera and species of termite in China, ranging from the extreme south up to Shanghai.

Altogether eight species belonging to seven genera have been reported from China (See Prof. S. F. Light, in *The China Journal of Science and Arts*, Vol. II, No. 1, pp. 50-60, and following numbers), of which the commonest form seems to be *Coptotermes formosanus* Shiraki. Professor Light, while at the Amoy University studied the Chinese termites very closely, and in the paper already cited described some six new forms, namely: *Kalotermes sinensis*, from Kwangtung (Canton Province); *Cryptotermes campbelli*, from Hainan Island; *Reticulitermes fukienensis*, from Fukien; *Macrotermes barneyi*, from Hongkong and Fukien; *Termes hainanensis*, from Hainan Island; and *Capritermes sowerbyi*, from Hainan, Hongkong and Fukien.

Of these the last is interesting since in it the jaws of the soldier are peculiarly twisted and so are thought to resemble the horns of a goat, hence the generic name.

In the *Paraneuroptera*, or dragon-flies, there are two pairs of wings in the perfect insect, which are alike and not differentiated as in so many insects. The eyes are very large and beautiful, while there are well developed jaws. The larval stage is spent in



DRAGON-FLY NYMPH

the water, the young animal being carnivorous and armed with a powerful organ mounted with jaws, which it can stick out and draw back under its body at will, and with which it seizes its prey. There are a large number of different species of dragonfly to be met with in China, of which the largest belong to the genus

Aeschna. These magnificent insects are of a bright green colour, the wings transparent and colourless, the abdomen long and slender, and thickened at the end. A smaller genus, which is represented in China by a great number of species, is *Libellula*. In this group the shape is very much the same as in the former, the difference between them being mainly in their size. In some members of this genus, however, the abdomen is much wider and tapers towards the end, somewhat after the shape of the abdomen of the hawk moth. In this genus a great many very beautifully coloured species occur. A form in South China described as *L. variagata* has the wings beautifully varagated mauve and yellow. A very common species throughout China has the whole of the body a

A CHINESE DAMSEL-FLY (*Agrion*)THE MAY-FLY (*Ephemera*)

brilliant crimson, while yet others are blue or yellow. In the family *Agrionidæ* the abdomen is extremely long, very slender, and thickened as its distal extremity, while the wings are very much broader than in the members of the foregoing genera. One of the most beautiful of these is the species of damselfly in which the whole body and wings are of a black colour with a strong green, metallic sheen. These beautiful insects may be seen fitting in great numbers over streams and along river banks of the interior. A closely related form has the front pair of wings colourless. Several very much smaller species belonging to this family are also to be found.

They are extremely delicate in shape and generally of very beautiful shades. In one of these the legs are peculiarly flattened into broad, wide, paddle-like blades. Dragon-flies, being carnivorous in both their aquatic and adult stages, preying as they do upon other noxious insects, should always be encouraged. The larval stage feeds upon the larva of mosquitoes, while the perfect insect feeds upon the same insect in its mature stage. House flies also fall a prey to the dragon-fly.

The members of the order *Ephemeroptera* are, like the dragon-flies, aquatic in their early stages. The well-known may-fly (*Ephemera*) belongs to this order. The nymph, as the imperfect insect is called, spends a considerable time in the water, but when maturity is reached it comes to the surface, splits its skin down the back, and the perfect insect, or imago, emerges. Floating for a few seconds upon the surface of the water with its wings folded and upright, the latter somewhat resembles a tiny yacht. Very shortly it starts to fly and rises into the air, where it enjoys a few hours of giddy excitement. During this period mating takes place and the eggs are laid. The insect then dies, falling back into the water, and is swallowed by some hungry fish. In some forms there is a sub-imago stage between the nymph and the imago, when the insect crawls from the water on to some rock or plant before splitting down the back and freeing the imago. In these insects the abdomen is rather long and has three long, slender feelers at the posterior end. The two anterior legs are very long and somewhat resemble antennæ, the latter being very short and inconspicuous. The wings are somewhat triangular, very gauzy-looking and exquisitely "veined." There are a number of different forms of dayfly, as they are alternately called, some of which are very small. In late spring and early summer they begin to appear and for several weeks at dusk the air becomes full of their elf-like forms, at which time they provide a very rich feed for the fishes. In Manchuria I have seen the cast skins of the nymphs of these insects floating in a thick scum upon the surface of the rivers, showing that millions upon millions of insects must have been liberated in a single night. The escape of the imagoes from the water usually begins at dusk and continues throughout the night.

Another group of insects that belong to the same order is that of the family *Perlidae*, or stone-flies. Here again the larval stage is spent in the water, while the imago spends a short and very

active life on land and in the air. Metamorphosis takes place very much as in the may-fly. Stone-flies usually are to be found running about upon the banks of streams rather than spending their whole time flying in the air. They are always in a desperate hurry, rushing about in a mad kind of way, presumably searching for their mates. Theirs, too, is a very short existence in the perfect stage. When daylight comes they hide themselves under stones which is presumably why they are called stone-flies.

The corn-flies (*Thysanoptera*) are very minute insects which may be found on flowers or grasses, and which are commonly known in England as thrips. The wings are somewhat peculiar, being very slender and having the edges lined with hairs.

In the members of the order *Trichoptera*, commonly known as caddis-flies, there is an aquatic larval stage as in the dragon-flies, and may-flies, but the larva, instead of being free swimming, makes for itself a little cylindrical case which protects its body very much as in the caterpillar of the Psyche moth, which the reader will remember was mentioned in the previous chapter upon the *Lepidoptera*. It does not swim, but crawls about on the bottom of streams and ponds, or over weeds and roots in the water. Strangely enough the perfect caddis-fly bears a considerable superficial resemblance to some forms of moths, the shape of the wings being very much that prevalent in the *Microlepidoptera*, while they are also covered with short hairs, which make them resemble the wings of *Lepidoptera* which are covered with minute scales. All sorts of materials are used by the different species of caddis-worms in the construction of their cases,—sand particles, leaves, little chips of wood, and even the shells of certain forms of water-snails, each particular species of caddis favouring some particular building material.

A peculiar characteristic in the caddis-fly is that the pupal stage is motile, the pupa being propelled through the water by two of the legs which stick out on either side like oars.

The true *Neuroptera* comprises a number of extremely interesting insects, the first of which to be mentioned is the alder-fly, which is so extensively used by anglers. The nymph of the alder-fly is a very ugly creature, having a large head, tapering abdomen, and numerous tracheal gills down either side of the abdomen which look like legs. It is of a black colour. Some forms in China reach a large size, specimens of over two inches in

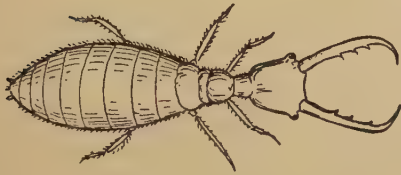
length being common. The perfect insect somewhat resembles the stone-fly, but is more sturdy in its body and has broader wings.

The life history of the ant-lion (*Myrmeleon*) is particularly interesting. The larva is in the form of a flat-bodied grub with slender thorax and rather large head. The latter is armed with very long serrated pincer jaws. Living only in sandy areas, the larva of the ant-lion makes for itself a small pit, and by peculiar jerky motions of the head throws the sand up the sides till these are perfectly smooth, and have a somewhat sharp slope. The grub then lies in wait at the bottom of the pit, buried in the sand. Any insect, such as an ant, which happens along and gets on to the sides of the pit, immediately slides down to the bottom owing to the looseness of the sand, where it is seized by the ant-lion, sucked dry, and then thrown out by the rapid jerks of the creature's head. Ant-lion pits may be found anywhere in dry weather where sand occurs. If the observer so desires, a specimen of this interesting insect may be placed in a box with sand, when the whole operation described above may be watched. In burrowing, the grub moves backwards by rapid up-and-down motions of its abdomen. The adult insect somewhat resembles the dragon-fly in general appearance, its abdomen being long and slender and the wings graceful and beautifully "veined." It may be at once distinguished, however, by the fact that it has rather longer club-shaped antennæ, while when it rests the wings are folded down the side of the body, which never happens in the case of the dragon-fly. The insect is also much softer in its body than is the dragon-fly. Often the wings are beautifully mottled with a dark colour. As a rule, the ant-lion insect only flies at night, making its appearance upon verandahs or in rooms to which it is attracted by the light.

Another interesting member of this order is the *Ascalaphus*. In this insect the adult very frequently bears a remarkable resemblance to a butterfly, the wings being very broad, the antennæ knobbed at the tips, and the head and body covered with hairs. In districts where these insects occur there is very frequently some member of the *Lepidoptera* (Butterfly) to which it bears a close resemblance. I well remember coming across an instance of this in Manchuria, where in the open glades of the forest I found the two forms flitting side by side over the flowers, and it was some time before I realized that one of these was a butterfly and the other a neuropteran.

The scorpion-flies (*Panorpidæ*) also belong to this order, and they are remarkable in that the males have the last segment of the abdomen in the form of a pair of pincers, while the abdomen itself curls up over the body much as does the "tail" of the scorpion. In the females these pincers are absent. The grubs live in decaying timber, the eggs being laid by the female in little cavities in the ground.

The lace-wings and aphs-lions are very beautiful insects, members of the true *Neuroptera*, usually of pale emerald green colour. In these the wings are large and broad and exquisitely "veined." In one genus, *Chrysopa*, the eyes are of a beautiful golden colour. The larvæ of these insects inhabit plants, where



LARVA OF ANT-LION (*Mermoleon*)



Ascalaphus

they feed upon such creatures as plant lice and other small insects. They are armed with powerful jaws. In some forms the adults possess a very powerful and disagreeable odour.

Any or all the insects described here are to be met with in gardens provided that conditions are favourable. An examination of artificial ponds will reveal the presence of the forms which have an aquatic larvæ, while the other forms make their appearance from time to time. None of them can be described as noxious, so that, one way and another, the whole group should be favourably looked upon by the gardener, the beauty of the members adding considerably to the æsthetic side of the nature lover's life.

CHAPTER XXXI.

THE MOSQUITO IN CHINA.

Everybody living in China is familiar with the mosquito, or gnat, as the pestiferous little insect is called in England. At Home it is a comparatively rare thing to be bitten by a gnat, and if, by chance, one happens to be staying where such insects are at all plentiful, one considers it a great hardship.

But in China, when the warm weather comes on, the mosquito makes its appearance, and is accepted by all as a matter of course, though precautions may be taken to safeguard oneself against its viciousness and the evil effects it brings in its train. As the season advances, evening and night are made hideous for all. Unless the house is well screened, or is situated in some specially favoured spot, where ponds and creeks are not, an evening party is a torment. The silken hose of fair guests become spotted with crimson, and men grow restive at the festive board. Fans are called for, and the menials bring "joss" sticks and set them a-smouldering, but the strained and harassed expressions upon what should be smiling faces remain, and ere long the guests politely thank their hosts for a very pleasant evening, and hurry away to seek the friendly shelter of their homes and mosquito-nets. The host and his wife also beat a hasty retreat. I well remember once. . . . but, no, I will not describe the awful experience of a party dining on a verandah at an hotel in Tientsin, the members of which were not sufficiently well acquainted to indulge in. . . . no, a veil must be drawn over that tragic episode.

All this takes place in town, where some effort is made to cope with the pest. Up country it is ten times worse. But too much is known at first hand of the horrors of *Culex* and her congeners to call for further comment. I propose, rather, to discuss the less well-known phases of the mosquito question, the biology of the insect, its distribution, habits, and the means adopted for its destruction.

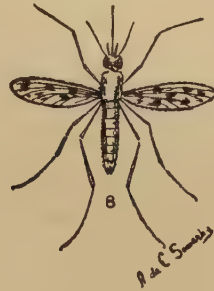
The word mosquito is Spanish, meaning "a little fly." The

name is a good one, for the mosquito does, in fact, belong to the great order of insects known as *Diptera* (two-winged), which includes the house-fly, the blue bottle, the gadfly, the warble-fly, the robber-fly, the crane-fly, or Daddy-long-legs, and a host of others, scarcely one of which is not in one way or another an enemy of man.

When one considers what terrible things insects are, one cannot help thanking the powers that be that the laws of mechanics are such as to have precluded them from ever attaining any degree of size. Constructed as they are, with their skeletons outside and their muscles encased within, it is a mechanical impossibility for them to approach ourselves in dimensions. Insect anatomy was



THE BANDED MOSQUITO
(*Stegomyia fasciata*)



THE MALARIA MOSQUITO
(*Anopheles sinensis*)

one of Nature's experiments in mechanics, and in many ways it was a failure. Comforting thought!

Universally distributed over the face of the globe, the mosquito is represented by a great many different genera and species. Each country has its own particular kinds. There are several species in China, ranging from the great yellow *Armigeres ventralis* of Walker, the largest of the lot, down to the deadly *Anopheles sinensis* (Wied), which carries and distributes the germs of malaria, and is one of the smallest.

The members of the Public Health Department in Shanghai have run down and identified the following species breeding in the vicinity :

1. *Culex fatigans*, Wied., the common form, which may be recognized by its medium size, uniform yellowish-brown colour without any markings, and the position it assumes when at rest, the thorax being somewhat humped and the abdomen parallel with the surface upon which the insect rests.
2. *Stegomyia fasciata*, Wied., the rather large black fellow with white-banded sides, and long hind legs sticking up in the air as the insect is at rest. This species is particularly virulent, its bite causing great irritation.
3. *Armigeres ventralis*, Walker, the very large yellowish form.
4. *Anopheles sinensis*, Wied., the malaria-bearing form, which may be recognized by the mottled appearance of its wings, and the position of the abdomen when the insect is at rest. This is held at an angle to the surface upon which the insect rests, the posterior end pointing upwards.

There are doubtless other species in the neighbourhood, but these are the kinds that worry us most.

The sting of the mosquito is only the least of the evil characteristics of the pest. In recent years the attention of men of the medical profession has been drawn more and more to the disease carrying propensities of most blood-sucking parasitical insects, and the discoveries made in this field of research have been a revelation. Of the four species of mosquito just described *Culex fatigans* is the bearer of a blood-infesting nematode worm (round worm) called *Filaria sanguinis hominis*, found, as its name suggests, in the human body. *Filaria immitis*, the worm which causes the death of so many dogs out here through the disease known as "worms in the heart", the worm, long, slender, and white, collecting in masses in the right auricle and pulmonary artery, has for its intermediate host the same, or a closely related, species. *Stegomyia fasciata*, the black and white banded form, is probably the potential carrier of the dreaded yellow fever, or "Yellow Jack", while everybody probably knows that *Anopheles sinensis* carries the deadly germs of malaria from one human being to another.

The story of the discovery of the disease-carrying character of mosquitoes reads like a romance. Brave men sacrificed their lives,

deliberately and fully knowing the nature of the deaths they faced, in order to serve humanity, and their discoveries might well have called forth from the poet the lines :

This day relenting God
Hath placed within my hand
A wondrous thing ; and God
Be praised. At His command,
Seeking His secret deeds,
With tears and toiling breath,
I find thy cunning seeds,
O million-murdering Death.
I know this little thing
A myriad men will save.
O Death, where is thy sting?
Thy victory, O Grave?

The importance, then, of getting rid of mosquitoes will be patent to the meanest intellect—though it is extraordinary how difficult it is for authorities to enlist the steady co-operation of the people they desire to protect from the diseases that are spread by these active and vicious insects.

In devising methods of destroying pests, the first thing to be done is to study their life histories. It so happens that the life history of the mosquito is of unusual interest. The eggs are laid on the surface of still or stagnant water in the form of a little saucer-shaped raft. There are some 300 of them in a raft, and within a few hours of being laid they hatch out and a swarm of tiny “wrigglers” are set free into the water. These grow apace. In the larval form the mosquito is elongate, somewhat maggot-like, with a swollen anterior portion. It has what are called tail-tubes at the posterior end of the abdomen, and by means of these the larva hangs, as it were, to the air-surface of the water, breathing. It may be remarked that the larva of *Anopheles* does not possess these tail-tubes, and when at the surface of the water assumes a horizontal position instead of a more or less vertical position as do the larvae of other species. The mosquito larva is fully grown in ten days’ time, at which period of its existence it undergoes a change, casting its skin and appearing as a pupa. As a pupa it can no longer feed. Its appearance is very different from

that of the larva, the anterior part being very much more swollen, and the abdomen slender. The creature now breathes through tracheae, or air tubes, on the thorax. It is active, in which particular it differs markedly from the pupae of most insects, which go through a period of quiescence at this stage. For four or five days the pupa wriggles about in the water, and then suddenly splits down its back, the imago, or perfect insect, emerging from its empty shell. A few minutes later the fully fledged mosquito is ready for flight. If it be a female it seeks and attacks some warm-blooded animal, if a male it fritters away its short life in an orgy of love and play. In mosquito land "the



LARVA, PUPA AND ADULT MALE AND FEMALE OF THE COMMON MOSQUITO
(*Culex fatigans*)

female of the species is more deadly than the male" with a vengeance. The male cannot even bite. He may readily be distinguished from his fierce spouse by his feathery antennae, those of the female being almost plain. The insects leave the water, and during the day seek shelter in dark, damp, and shady places. Apparently they cannot stand the fierce rays of the sun, though some forms may be seen abroad in daylight during cloudy or rainy weather. But *Anopheles* is said never to fly abroad during the day. It is possibly this habit of seeking dark shelters that leads mosquitoes to show a preference for dark objects. It has been found that mosquitoes prefer dark blue or black to other colours, caring least of all for white and khaki.

There is another interesting point about *Anopheles* as compared with other species. It will not breed in sewage water.

In attacking the mosquito, advantage is taken of the necessity of the larvae and pupae to breath air, and it has been found that by pouring kerosene oil upon water infested by these "wrigglers," a thin film is formed upon the surface. This clogs the air-tubes of the larval and pupal mosquitoes and so suffocates them. This method has proved extremely effective, especially in places where large areas of stagnant water occur. The construction of the Panama Canal was an impossibility till this method of destroying mosquitoes was discovered and applied, and, by destroying the mosquitoes, getting rid of the yellow fever, which up till then had killed off thousands of men employed on the work. It was Colonel W. C. Gorgas who organized the fight against the mosquito in the Panama Isthmus, and finally cleared the place of the dread fever.

Recently further experiments have been carried out in order to discover means of destroying mosquito larvae in water whose surface is exposed to the wind, for which, or for any other reason, the oil poured upon it does not form a continuous film. It has been found (see "Nature," June 10, 1922) that a liquid containing 15 per cent. of soluble cresol when added to infested water in the proportion of 1 to 16,000, kills all mosquito larvae and pupae in the space of one hour. In the proportion of 1 to 32,000, it kills them in an hour and a half, and in the proportion of 1 to 48,000, in three hours. Nor is the water so treated poisonous to man or beast. This seems to be an almost better method of destroying the pest than that in which oil is used.

Other means may, however, be adopted with success. For instance, small fish of certain species that feed on mosquito larvae may be introduced into the infested ponds. In the waters of the Barbadoes there lives a tiny fish, popularly called "millions", and known to science as *Lebistes poecildoes*. It is believed that the immunity of the island from malaria is due to the presence of this pretty little fish. It breeds very rapidly and is vivaparous, and, but for the fact that it is very difficult to acclimatise, this little fish might well be introduced into the waters of countries where mosquitoes are a pest as they are in China. Other countries, other fish, seems, however, to be the idea, and in China there are a number of small species that might be given a trial. The beautiful little paradise fish (*Polyacanthus opercularis*) and the

bitterling (*Acanthorhodeus asmusi*) might be tried in the central and southern areas, and the minnow (*Phoxinus lagowskii*) and the loach (*Nemacheilus barbatulus toni*, Dyb.) in more northerly regions. These species can always be secured alive in large numbers.

Of course there are a number of other creatures that willingly assist man in his fight against the mosquito. The large black cockroach is one, the long-legged and horrid-looking millipede another, the friendly little gecko, or wall lizard, is yet another, nor is the spider with her web to be despised. Housewives may object to harbouring such creatures in their homes, but think of those beautiful lines in the Arabian Nights, and give them a chance.

Shall the beautiful hue of the basil fail,
Though the beetle's foot o'er the basil crawl?
And though spider and fly be its denizen,
Shall disgrace attach to the Royal hall?
The cowry, I ken, shall have currency,
But the pearl's clear drop, shall its value fall?

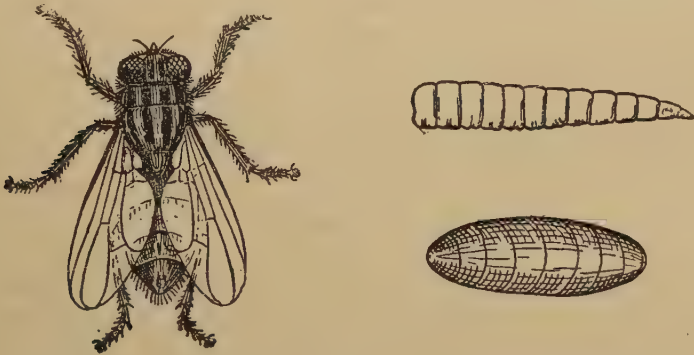
It is rather a remarkable thing that the further north one travels, the more numerous mosquitoes become. Tropical climes are bad: semi-tropical climes are worse: but it is in such countries as Mongolia, Manchuria, Siberia, and Alaska, that these pests are to be found at their worst. Here they swarm in countless millions. Words are inadequate to describe the terrors of the short summer in these parts, and when the traveller has exhausted his vocabulary in an effort to convey to his listeners an idea of what it is like, he is still far from having expressed the real state of affairs. It is unbelievable unless experienced. The short warm summer, and the extensive areas of water-logged land, the great swamps, the wide moss-beds, and the absence of any enemies to feed upon the larvae doubtless account for this remarkable state of affairs. But there is one mitigating circumstance. In the north the mosquitoes do not seem to carry disease about in the way they do in more tropical climes, doubtless because the diseases are not there to be carried about. Thus, the sojourner in these parts, having patiently endured the suffering to which he is inevitably subjected, need fear no evil consequences. Nature always compensates.

CHAPTER XXXII.

FLIES.

The common house-fly is so well-known that it is unnecessary to describe it, though it is probable that its life history is not generally known to the public at large. It is also certain that the vast majority of people in China are not aware of the fact that many of the deadly diseases which are so rampant in this country are distributed amongst human beings by means of flies. Nevertheless, that this is the case there is abundant medical evidence to prove.

This being so, it is evident that a universal knowledge of the life history and habits of the common house-fly and its relations, the blue-bottle, green-fly, or blue and green blow-flies, as they are



THE HOUSE-FLY (*Musca domestica*) WITH THE LARVA AND PUPA

alternatively called, and grey flesh-fly—all of which infest human habitations and are guilty of spreading disease—is very important.

And since it is just the time of year when flies begin to get in their deadly work, it is proposed here (and may prove profitable) to tell the story of the fly, at the same time explaining how it comes to be a carrier of deadly diseases, and suggesting means of destroying this noisome pest.

The common house-fly is known to science under the name of *Musca domestica*, and is a member of the family *Muscidæ*, which belongs to the great order *Diptera*, or insects with only two wings.

Most insects have four wings, but the mosquitoes, gnats, horse-flies, forest-flies, house-flies and the like, all of which in some way or other are harmful to man, have only two wings, by which fact that may easily be recognized.

They all have different life histories, propagating their kinds in different ways, so that each requires a special knowledge on the part of humanity in order to accomplish its destruction.

But of them all, the two most deadly are the common house-fly and the mosquito. The latter was dealt with in the preceding chapter: we are concerned here only with the former and its immediate relations.

The common house-fly lays its eggs usually in excreta of some sort, but the mother fly is not particular in this respect and chooses all sorts of places for the deposition of her large brood of eggs. Food of various kinds that have been left to go stale may be chosen. Refuse heaps, garbage piles, dust-bins and the like are very favourite places, especially if these are left for any length of time without being carted away or emptied. Stables and open privies, such as are used throughout the length and breadth of China, are, however, the places most sought after by the house-fly and her relations in which to lay their eggs, and there the latter hatch out very quickly—within a few hours of being laid—and the young maggots, little white threads, begin to feed. They wriggle all over the place feeding prodigiously as they move. Night and day they go on feeding and their growth is correspondingly rapid. In a few days they have attained their maximum growth, when, if circumstances permit, they creep away, and, hiding in some dark corner, under a stone or deep down in the garbage pile, they turn into what are known as pupae. They change from being ugly white maggots that wriggle over the ground, to elongated egg-shaped chrysalids of a rich red-brown colour, that cannot move, but lie quietly in their chosen place for a number of days. Inside each red-brown case a wonderful thing is happening. The soft white juicy tissues of the maggot are rapidly differentiating. Legs, wings, head, eyes, mouth, tongue, and hairs are forming, and presently there comes a day when the cap of the pupa shell is pushed off, and there emerges a rather soft weak fly, whose wings are all crinkled up. Very soon the wings straighten out: the insect finds its way through all the filth and mess that surrounds it to the open air. There it stretches its legs, crawls about, buzzes its

wings, cleans itself all over—though without getting rid of the millions of minute germs that are adhering to its feet and body, spreads its wings and flies away from its erstwhile home.

And it is now that the fly begins to be an actual danger to man. Consider its recent home, the dirt and filth of the garbage pile, the germ-filled excreta of the stable, or privy. Its legs and body are covered with deadly germs, harmless to itself but ready to attack any human being.

The fly enjoys life very much. It comes out into a world full of good things. Its sense of smell directs it to food shops, kitchens, and even the dining table. There it partakes of all the delicacies laid out for human consumption. Nothing escapes it; it tries everything—meat, milk, rice, fruit, sugar. It walks over the food with its germ-covered legs, leaving the germs everywhere, and presently along comes some human being, perhaps a strong man, perhaps only a little child, and eats the food. The germs are taken into the stomach and immediately begin to multiply, and soon the strong man is laid low, the child sickens, and death visits the household.

But the fly is not satisfied. It is still alive and busy. It flies away to some other house, perhaps visiting on its way a stables or a garbage pile from which odours that are attractive to flies pervade the air. When it leaves the latter more germs are on its feet, and these are deposited on more food, and more human beings are taken ill, and more coffins are ordered.

By and by, the fly—if it be a female—feels the mother impulse coming on, and away she goes to the nearest garbage pile or stables, or other place where the filth that her young require is to be found. There she walks about, sucking up decaying, germ-filled matter with her tongue, now and then stopping to deposit her eggs. She lays somewhere about five hundred eggs, and then, her maternal duties over, she hurries back to the more delectable food of the human household, where she adds to her crimes by depositing her own germ-filled excreta promiscuously over the food.

One day, however, she is overtaken with vengeance. While taking in germs that only affect humans, she has also taken in the spores of a fungus deadly to herself, and lo! her abdomen swells up, becomes white and opaque, and she dies, clinging to a wall or the ceiling, where she may be found by those interested enough to look.

But what has she done? Five hundred little maggots, her offsprings, are wriggling through the filth of the garbage pile, and soon there will be 500 more flies, of which at least half will be females, and each will lay in due course 500 more eggs, which again in a few days will be flies and half of which will each lay 500 more eggs. In less than a month after she laid her brood she will have over *thirty millions* of descendants, each flying about the place depositing germs wherever it settles, each potentially capable of carrying death to numberless human beings!

If reproduction is kept up at the same rate her descendants will number over twenty-eight billion billion in four months. That is to say, if a single pair of flies exist in a given area at the beginning of April and are allowed to multiply unchecked and nothing happens to any of their descendants, by the end of July, that is, the middle of the hot weather, there will be over twenty-eight billion billion flies, of which half at least are the potential ancestors of over thirty millions flies by the end of August.

These figures stagger the human mind, but they are as nothing when compared with the figures in connection with the multiplication of the microbes and germs which the flies disseminate; and when one comes to consider what it means when twenty-eight billion billion flies are turned loose on the human race, each carrying possible disease and death to some member of that race on its feet or in its body, one wonders how there are any people left in the world at all. Fortunately Nature herself interferes in a thousand ways to keep down the pest, but even so incalculable numbers escape destruction and threaten humanity by means of their filthy habits.

In China the fly is a particularly noisome pest, and, owing to the primitive—often complete absence of—means of sanitation, breeds almost unchecked—quite unchecked as far as the human population is concerned.

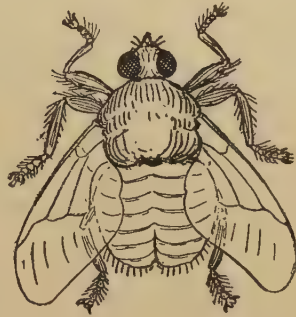
In some places in the interior they occur in the towns and villages in such numbers as to render life to the fastidious European absolutely insupportable. While travelling in the west of Shansi one summer the writer reached a town named Liu-lin Hsien, situated in a pleasant valley mainly devoted to the cultivation of the indigo plant. It was a market day, and the streets were crowded with pedlars of all kinds of fruit and other eatables, and as one looked up the main street one could see a dense haze

hanging over everything. This haze was caused by countless myriads of flies that hovered over the booths. The food was literally black with flies. It was the most appalling sight of its nature any of the party had ever seen. Arriving at the inn for our noontide halt we found things just as bad there. None of us could touch a morsel of food, hardened to such things though we had become through months of travel and roughing it. The mules were hurriedly fed, and the caravan started off again with all speed, and on looking back as we left that unholy spot it was to see the dense grey haze hanging over everything.

The natives attributed this swarm of flies to the fact that in



THE HORSE-FLY (*Tabanus*)



THE FOREST-FLY (*Hippobosca*)

order to extract the dye, the indigo plants have to be placed in large vats where they undergo partial decay, forming an attractive breeding-ground for the insects.

The diseases carried by the house-fly are mainly such as attack the human system through the alimentary tract, and of these the most deadly are enteric fever, typhoid fever, cholera, and the various kinds of dysentery. Some of these, it is true, may be taken into the system in water or milk, but in most cases it will be found that flies are responsible, and the trouble is that no matter how careful one is to keep food covered up, if there are any flies about, sooner or later they will get upon it, leaving no visible trace

or sign that they have been there, yet leaving the germs of diseases, a menace to the inmates of the house.

This means that the only way to safeguard oneself and one's family is to destroy the fly altogether. There is no other way. If flies are allowed to enter a house, sooner or later death will visit that house as a direct result. It may be a little child that dies, it may be the mother leaving the children uncared for. It may even be the breadwinner.

All sorts of ways and means have been devised to exterminate flies or to keep them out of our houses—screened doors and windows, Japanese fly traps, fly paper, disinfectants. Garbage piles are removed daily; stables kept clean; privies sprinkled with powerful disinfectants. There are some useful remedies on the market in the way of sprays, powders, and the like, and the householder is recommended to adopt every possible means in order to keep down the flies. The Public Health Department of the Shanghai Municipal Council has issued valuable instructions in regard to keeping food safe from flies, and these should certainly be strictly adhered to.

Besides the common house-fly there are the large carrion, or blow-flies already mentioned.

The green-fly is closely related to the house-fly, albeit belonging to a different genus, *Lucilia*. It is much larger, and is of a brilliant metallic green colour with large red eyes. It is extremely abundant, and comes into human habitations in large numbers, walking over the food. It too carries deadly germs, for it lays its eggs in dead bodies where its white maggots wallow through the decaying and putrid tissues. Its habits are otherwise similar to those of the house-fly. Its scientific name is *Lucilia silvarum*.

The same applies to the bluebottle, known to science as *Calliphora erythrocephala*. This large insect is of a bluish colour, and is covered with hairs, in which characteristic it differs from the green-fly. It too deposits its eggs in carrion; and is a frequenter of human habitations.

The grey flesh-fly (*Sarcophaga carnaria*) is another infester of carrion and visitor to human dwellings. It is even larger than the foregoing species, and differs from other flies in that it is viviparous, that is to say, its young are born alive and are not first deposited as eggs. It is very prevalent round open privies, where it breeds extensively.

Besides these germ-carrying flies, there are others which sting and annoy human beings in this fashion. Or they attack horses and cattle, dogs and sheep, causing these animals great suffering during the summer. Or their grubs become parasites within the bodies of these domestic animals.

Amongst these may be mentioned the horse-flies (*Tabanus*) which particularly attack horses and cattle; forest-flies (*Hippobosca*) which attack dogs more than anything else, and the bot-flies (*Gastrophilus*) and warble-flies (*Hypoderma*), the grubs of the former of which are parasitical in the intestines of horses, mules and donkeys, those of the latter being parasitical under the skins of sheep and cattle, ruining the hides for commercial purposes, and causing the animals great suffering.

Before leaving the flies mention should be made of one or



THE WARBLE-FLY (*Hypoderma*) AND ITS LARVA,
AS TAKEN FROM UNDER THE SKIN OF A DEER

two groups that are not harmful to man. Foremost amongst these are the robber-flies of the family *Asilidæ*. So far from being man's enemies these flies are his friends, for they actually prey upon other noxious species. They are large flies with long, rather slender abdomens, and thick swollen thoraxes, much as in mosquitoes. They are to be met with commonly on open roads, where they lie in wait for horse-flies (*Tabanus*), upon which they pounce, and holding firmly suck dry. These flies never touch human beings or animals. They are common in China.

The hover-flies (*Syrphus*) of the family *Syrphidæ* somewhat resemble certain of the bees and wasps. They derive their name from their habit of hanging poised and motionless in the air except for the rapid vibration of their wings, every now and then making rapid darts in this direction or that.

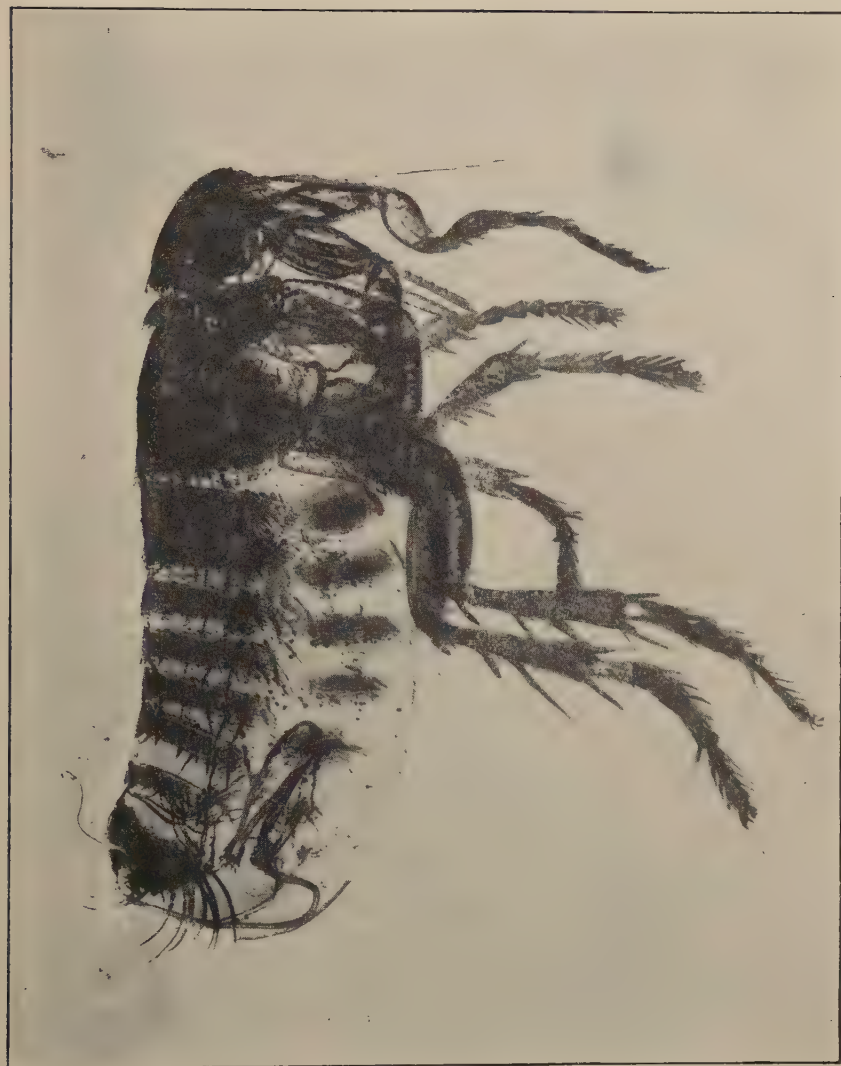
To this family also belong the drone-flies and humble-bee flies. All these forms are predaceous or parasitic in some way or other.

With the flies are usually classed the fleas*, since, except for the absence of wings in the latter, the two groups are very closely similar. It is superfluous to state that fleas are numerous in China: everybody who has lived in this country is perfectly well acquainted with the fact. But it is doubtful if they realize how prevalent these insects are, or how many different species exist. Apart from the common form that occurs in human dwellings, there are a great many forms that infest various species of wild animals, and which are either unwilling or unable to attack man. Almost every different group of rat has its own particular flea: and but few of these have as yet been made known to science.

One of the most interesting of fleas is a species of jigger flea (*Vermipsylla dorcadia*), which infests the roedeer. The female has the body greatly distended, so that it looks like a fat white maggot, and it is usually to be found in the nostrils of its host. The male is a small black flea infesting the pelt of the deer.

The eggs of fleas are laid by the female in the coat of some animal, or in some other suitable spot. They hatch out in due course into little white maggot-like larvæ. At this stage their home is the ground, and their food little particles of animal or vegetable matter that help to form the dust and debris. After pupating, the perfect insect seeks some suitable host, and so completes the life cycle. From this it may be gathered that if houses are kept really clean, and there are no cats or dogs to bring fleas in from outside, they should be entirely free from these pests. The moral is obvious.

*The fleas are now placed in an order of their own called *Siphonaptera*.



THE MALE OF THE JIGGER FLEA (*Vermipsylla dorcadia*, Rothschild)
Taken from a Roedeer in Shensi

CHAPTER XXXIII.

BEES, WASPS AND ANTS.

No account of the insects of China could be considered complete without reference to the large and varied order known as the *Hymenoptera*, or insects with membranous wings. It might be argued that the wings of most insects are membranous, and in truth this is the case. On this account the name is not altogether a good one, but it has served for a very long time, and it is not for us to change it.

The *Hymenoptera* come nearest to the flies (*Diptera*) in general appearance, in many cases it being not easy at a casual glance to say to which of these two orders an insect belongs. But a close examination reveals the presence in the *Hymenoptera* of four wings (except in the case of the wingless forms, such as ants), while in the *Diptera* there are only two, as the name suggests. In the *Hymenoptera* there are always strong cutting jaws; in the *Diptera* the mouth parts are either in the form of a long piercing and suctorial proboscis, or a sort of fleshy protractile tongue. Many of the *Hymenoptera* are armed in the abdomen with stings. Flies when they sting do so by means of their piercing proboscis.

Some of the members of this great order are amongst the most specialized of all insects, not, it is true, so much in their physical forms, but in a direction that brings them, as it were, very close to man. This is their social organization.

Where flies breed in enormous numbers and occur in great disorderly mobs, and beetles live a lonely and unsociable life from the time the egg is laid in its appointed place till the adult insect ends its life in solitude, many of the bees and ants, and to a lesser extent the wasps, form into colonies, social states, insect cities—call them what you will—wherein law and order prevail, and each inmate has its appointed task and does it with a will. These busy little insects have carried socialisim to the point almost of perfection, each individual functioning according to its bodily form and capacity, and caring not a jot what becomes of it so long as

its task is fulfilled. Each gives its little all for the colony, working feverishly throughout its whole life, and asking nothing but the welfare of that colony in return.

Here we have no rivalry except amongst the Queen Mothers, whose business it is to rival one another so that the fittest may survive to be the progenitor of future generations. The vast majority of the members of these self-contained insect states know no joys in life except that of working. Instinct is their master, the survival of the race their common aim. It has been suggested that while the bees and ants have greatly benefitted through their development of socialism, they have at the same time fallen behind other branches of animal life, since they destroyed individuality and initiative. This opens up an interesting line of thought.

But we need not enlarge upon this phase of our subject; Maeterlink in his "Life of the Bee" has told the story in his own inimitable way, and a host of other writers have added their quota to our knowledge of the ways of these hymenopterous insects, which occupy every type of country in all parts of the world.

And China is not behind other countries in the number and variety of her bees, and their relations, the wasps and ants. She has her honey bees (*Apis*), wild and tame, and their poor relations, the humble bees (*Bombus*), whose small rounded nests of moss may be found on the ground in dense underbrush. These belong to the family *Apidae*, or social bees. She also has her carpenter-bees (*Xylocopa*), big black fellows that bore into the roof beams and supporting wooden pillars of native houses and temples, and which with the following are known as solitary bees and belong to the family *Andrenidae*. One group of large bee is remarkable for the presence of a peculiar cavity situated in the anterior dorsal part of the abdomen. This cavity is always occupied by a certain species of mite, which, however, does no harm to the bee: indeed, it is believed that in some way the bee and the mites are mutually beneficial to each other. The flower-bees, (*Anthophora*) are both numerous and varied, while mason-bees (*Chalicodoma*), which build mud homes for their larvæ, solitary bees (*Andrena*), which burrow into the hard ground, and leaf-cutter bees (*Megachile*), which cut round sections out of rose leaves to line their borings in trees—all are to be met with in China. As to the specific names of the various forms, it is extremely doubtful if more than a very

few of them have been definitely identified or described. Indeed, specimens which were sent home by the writer years ago have remained till now unidentified beyond the genera to which they belong.

In China honey-bees are not cultivated to anything like the extent they are in other countries. Honey is looked upon more as a medicine than a sweetmeat, and the apothecaries invariably adulterate it heavily with malt or even flour. Certain fruit conserves, notably jujubas, or Chinese dates, are treated with honey, which makes them extremely palatable.

In the wilds of Shansi, Shensi, Kansu and Szechuen, many of the villagers keep bees somewhat extensively, while in the Manchurian forest areas the settlers have learnt their value, and set



A COMMON CHINESE WASP (*Polistes hebraeus*)

out specially hollowed tree trunks, stood on end, to attract the wild bees when they swarm. But nowhere is apiculture reduced to an art or looked upon as much more than a profitable hobby.

Next to the true bees come the true wasps, which again are divisible into two groups: those which are solitary in their habits, and those which form into colonies. Of the latter there are numerous species in China, one of the commonest of which is known to science as *Polistes hebraeus*. This is the rather large species commonly found in dwellings, where its pendulous paper nest may often be found. It is of a redish-brown colour, and when flying lets its legs hang down in a very characteristic manner.

A hornet, much like the European hornet (*Vespa crabro*) is

prevalent, being more common in some parts than others. A yellow wasp, like the British common wasp (*V. vulgaris*) also occurs, as also does a small species that makes its nest, like *V. germanica*, under ground.

In Fukien province a species of *Ischnogaster*, which builds a very peculiar bottle-shaped nest is to be met with.

Some of the mud-wasps (solitary group) are interesting on account of their habit of storing away the grubs of other insects in their mud dwellings as food for their larvæ. This helps to show their affinities with the predacious wasps of the families *Sphegidae*,



Nest of *Ischnogaster*, a species of wasp. Usually it is produced below in the form of a funnel with an opening at the bottom by means of which the mature insect escapes. Inside are six or seven large chambers, each designed to harbour a grub. The nest is a variation of the usual paper nest of *Polistes* and *Vespa*, the common wasps

Crabronidae, *Philanthidae*, *Pompilidae*, *Bembicidae*, and *Mutillidae*. In all these families the members capture other insects, or their grubs, including the honey-bees and humble-bees and store them away in their nests as food for their young. They have a multiplicity of form, size and colour. Some build nests of mud, others utilize burrows of other animals. The members of the *Pompilidae* attack large spiders, paralyze them with their stings, and then bury them away in some hole or corner, there to await the hatching out of the wasps' eggs which have been deposited close by. Some members of the genus *Pompilus* are very large and

handsome insects. Some are all black, others black and yellow or red, in which colouration they resemble the members of the *Sphegidae*, while the members of the other families mentioned above are mostly banded black and yellow or black and orange. In the family *Mutillidae* the females are wingless.

In the ants, which constitute a large and varied family (*Formicidae*) of the order *Hymenoptera*, we have a very high social state; in many cases even more specialized than in the honey-bees. Here we have, in addition to the egg-laying females or queens, males, workers and certain sexless individuals with greatly enlarged jaws, whose function is that of warriors.

There is every evidence of ants being endowed with remarkable mental attributes, which alone could enable them to carry out their manifold activities. They distinguish readily between members of their own colony and those of others, even of the same species, which are always considered as enemies. Many species use plant-



Bottle-shaped mud nest of *Eumenes*, a wasp that captures small caterpillars and incarcerates them in the nest, where they remain alive till devoured by the wasp's larva

lice or aphides as cows, deliberately caressing these insects till they exude a sweet juice from their cornicles (stiff tubes on the back of the abdomen) called honey-dew. To insure a supply of this substance ants actually carry the eggs of the aphides into their burrows, where they rear the insects in specially provided chambers.

Many genera of ants go in for slave keeping, raiding neighboring colonies, killing the insects, and carrying off the eggs and larvæ, which are reared and become inmates of their captors' colony.

Many and varied are the forms of the nests of ants. Some live in subterranean tunnels; others make hills of bits of twigs, grass stems, and pine-needles; yet others build nests in trees by binding the leaves together with silk-like threads. Some forms make huge nests of paper-like fibre, but never with the geometrically

precise chambers of the bees' and wasps' nests. In the case of the ants which use web in the construction or preparation of their nests, they get the web from their larvæ, which spin it from their mouths. An ant siezes a grub in its jaws and carries it about, the grub letting out web as it goes. When the grub's supply of web is exhausted, the ant discards it and picks up another; continuing this process as long as necessary.

The ants of China are very little known, though recently a certain amount of systematic and descriptive work has been done by Wheeler.*

In mountainous areas in the north, a large black ant (*Camponotus*) is very common, the large-headed warriors measuring over half an inch in length; the winged females and males during their dispersal period look almost like black wasps of some sort. Forms of the red wood-ant are also prevalent, while the small garden ants, and the smaller red ants that infest human habitations are very abundant.

In the south are many other forms, of which one that lives in woods stings like a bee, while another makes huge paper nests in trees.

Somewhat removed from the ants, but still belonging to the same group of hymenopterous insects, namely, the sub-order *Petiolata*, though included in a different section *Parasitica* (the ants, bees and wasps belonging to the section *Aculeata*), are the so-called burnished wasps. These are beautifully coloured insects, the surfaces of whose bodies are hard and shiny like burnished metal. Some are bright blue, others blue-green, others blue and crimson, and all have a bright metallic lustre. They are veritable living gems. The golden burnished wasp (*Stilbum splendidum*) is one of the largest and is of a brilliant blue with a golden sheen in the sunlight. It or a very closely similar form occurs in China, as also does a crimson and blue form (*Chrysis*). Some of these burnished wasps are truly parasitical and like the ichneumon wasps lay their eggs inside the bodies of the grubs of other insects.

The members of the *Braconidæ* are small wasps whose grubs develop inside the caterpillars of butterflies and moths, the eggs

* In *American Museum Novitates*, No. 69, 1923, ants collected by Profs. S. F. Light and A. P. Jacot in China are listed and new species described.

having been deposited there or in the eggs of the butterflies or moths by the parents.

A species of javelin-wasp (*Fænus*) is found in China. In it the abdomen is long and armed with a long ovipositor. It is parasitical on other hymenopterous insects.

There are a great many other parasitical wasps belonging to the family *Ichneumonidæ*. One of the most interesting genera is that known as *Ephialties*. In this the females are armed with long ovipositors with which they can penetrate deep into the wood of trees, puncturing the caterpillars of such insects as the goat-moth to longicorn beetles that bore in the trees. The writer has often found females of these insects upon the trunks of trees, apparently unable to withdraw their ovipositors after having pierced the tough fibres of the wood. It is truly remarkable how this wasp can drive her long thin ovipositor through the tough bark and wood of the tree in order to reach the grub inside. The presence of the latter is, apparently, detected by sound.

Gouty-legged wasps (*Smicra*) and chrysalis-stingers (*Pteromalus*) are also to be found in this country.

To this group of *Hymenoptera* belong the gall-wasps (*Cynipidæ*) which deposit their eggs in the tissues of plants, causing the various plant-galls as the larvæ develop.

Lastly we have the saw-flies, which belong to the suborder *Sessiliventres*. In this suborder the members have the abdomen attached to the thorax without the attenuation of the anterior segment of the former into a slender stalk, such as characterizes the *Petiolata*. There are three main families, the *Siricidæ*, the *Tenthredinidæ* and the *Cephidæ*. In some of these the females are armed with ovipositors, by means of which they deposit their eggs inside the stems of trees where the larvæ bore their way through the wood, feeding as they go. The grub of this saw-fly is especially pursued by the female *Ephialties* in her search for a host for her family.

The largest of these saw-flies is the giant-tailed wasp (*Sirex gigas*), in which the female is larger than the male and has the abdomen banded black and orange-brown, while the male has it red and black.

The pine saw-fly (*Lophyrus*) is a very small species of the family *Tenthredinidæ*, as also is the turnip saw-fly (*Athalia*), while the green saw-fly (*Tenthredo*), of a bright green colour and banded

black and yellowish on the abdomen, is the most beautiful. It is to be found on the foliage of certain bushes, where it feeds on flies and other insects. A species is common in China as also are species of the other saw-flies mentioned.

The corn saw-flies (*Cephus*) belong to the family *Cephidae*, and somewhat resemble the ichneumon wasps in appearance.

